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EVALUATION OF SAFETY PROGRAMS WITH RESPECT TO THE CAUSES OF AIR--ETC(U)
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Report No. ASP 80-1

EVALUATION OF SAFETY PROGRAMS WITH RESPECT TO THE CAUSES OF AIR CARRIER ACCIDENTS

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January 1980

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Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation System Plans
Washington, D.C. 20591

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NOTICE

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AIR CARRIER CAUSE/FACTOR CODES USED IN THE SAFETY PROGRAM ANALYSIS AND EVALUATIONS

C/F Code	Description
64*01	Decision (pilot)
64*02	Execution (pilot)
64*03	Cognition (pilot)
64*04	Physical Incapacitation
65*01	Decision (co-pilot)
65*02	Execution (co-pilot)
65*03	Cognition (co-pilot)
66*02	Execution (dual student)
67*01	Decision (check pilot)
68*D0	Improper Maintenance (personnel)
68*D4	Inadequate Inspection of Aircraft (personnel)
68*D6	Inadequate Maintenance and Inspection (personnel)
68*G9	Air Traffic Control (personnel, other)
68*J0	Production-Design (substandard quality control)
68*K1	Ground signalman
68*K3	Ground crewman
68*K4	Passenger
68*K0	Pilot of Other Aircraft
68*R	Flight Attendant
68*R0	Flight Personnel (flight attendant)
68*00	Personnel (all others)
68*K9	Miscellaneous Personnel
70*CA	Landing Gear (Main shock assembly structures)
70*CB	Landing Gear (retraction/extension assembly)
70*CC	Landing Gear (emergency extension assembly)
70*CE	Landing Gear (nosewheel assembly)
70*CF	Landing Gear (wheels, tires, axles)
70*CJ	Landing Gear (braking system-normal)
70*CM	Landing Gear (gear locking mechanism)
70*00	Landing Gear (all other)
74*AD	Engine Structure (cylinder assembly)
74*ME	Compressor Assembly (disc compressor rotor)
74*00	Power Plants (recip /turbojet)
75*BD	Hydraulic System (reservoir, lines, fittings)
75*00	Systems (electrical, hydraulic, flight control, etc.)
76*00	Instruments/Equipment and Accessories
78*00	Rotorcraft
80*BA	Airport Condition (wet runway)
80*00	Airport/Airways Facilities (all other)
82*B	Rain
82*H	Unfavorable Wind Conditions
82*K	Clear Air Turbulence
82*L	Turbulence in Flight (assoc. clouds/thunderstorms)
82*X	Thunderstorm Activity
82*00	Weather (all other)
84*7	Evasive Maneuvers to Avoid Collision
84*I	Undetermined Cause
84*J	Written Cause
84*00	Miscellaneous

AIR CARRIER ACCIDENT CODES USED IN THE SAFETY PROGRAM ANALYSIS AND EVALUATIONS

Code	Description
A	Ground-Water Loop/Swerve
B	Dragged Wingtip, Pod, Float
C	Wheels Up
D	Wheels-Down Landing in Water
E	Gear Collapsed
F	Gear Retracted
G	Hard Landing
H	Nose Over/Down
I	Roll Over
J	Overshoot
K	Undershoot
L0	Collision In Flight
L1	Collision One Airborne
L2	Collision Both on Ground
M0	Collision with GRD/Water Controlled
M1	Collision With GRD/Water Uncontrolled
N0	Collided - Wires/Poles
N1	Collided - Trees
N2	Collided - Residence
N3	Collided - Other Buildings
N4	Collided - Fence, Fenceposts
N5	Collided - Electric Towers/Wires
N6	Collided - Runway/Approach Lights
N7	Collided - Airport Hazard
N8	Collided - Animals, Livestock
N9	Collided - Crop
NA	Collided - Flagman, Loader
NB	Collided - Ditches
NC	Collided - Snowbank
ND	Collided - Parked Aircraft
NE	Collided - Automobile
NF	Collided - Dirt Bank
NY	Collided - Other Bird Strike
Q1	Stall Spin
Q2	Stall - Spiral
Q3	Stall - Mush
R0	Fire In Flight
R1	Fire on Ground
S0	Airframe Failure in Flight
S1	Airframe Failure On Ground
T	Engine Tearaway
U	Engine Failure Or Malfunction
V1	Propeller Failure
V2	Tail Rotor Failure
V3	Main Rotor Failure
W	Propeller/Rotor Accident-Person
X	Jet Intake/Exhaust Accident-Person
Y	Propeller/Jet/Rotor Blast Damage
Z	Turbulence
0	Hail Damage To Aircraft
1	Lightning Strike
2	Evasive Maneuver
3	Uncontrolled Altitude Deviation
4	Ditching
5	Missing Aircraft
6	Miscellaneous/Other
7	Undetermined

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16. Abstract The objective of this study was to determine the extent to which the FAA safety programs were aligned with the causes of air carrier accidents. The data base used in this study consisted of a total of 760 air carrier accident records compiled by the National Transportation Safety Board (NTSB) from 1966 through 1975. Analysis of these records was made with respect to NTSB-cited cause/factors. FAA programs implemented during the study time period and pertaining to safety were also included in this study.

Conclusions of this study are:
1) No substantive change is required with respect to mechanical safety programs,
2) Broader investigation into the integration of environmental programs with human factors programs is required,
3) New program initiatives addressing human error problems in behavior terms are required.

Recommendations for further improvement in air carrier safety consist of:
1. Pilot error research
2. Pilot/crew awareness
3. Human factors and mechnical data system
4. Citation of cause
5. Collaboration with military researchers
6. Pilot error data feedback

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EXECUTIVE SUMMARY

This report provides an evaluation of the Federal Aviation Administration (FAA) safety programs with respect to the causes of air carrier accidents. This evaluation has been made in support of FAA planning aimed at improving safety in the National Aviation System (NAS).

In its responsibilities for safety in the NAS, the FAA continually conducts safety research and development, installs facilities and equipment, provides operational procedures, and implements and enforces regulatory standards. These programs, in conjunction with aviation safety activities of other Government agencies and the aviation industry, have contributed to an impressive aviation safety record. Yet, accidents still occur resulting in loss of life and property damage. Further, the aviation environment is constantly changing, manifested by increasing traffic and congestion, more sophisticated equipment, more complex operational procedures, etc.--all imposing new demands for maintaining safety in future aviation activity. To meet these demands for maintaining safety, the FAA recognizes the need for empirical assessments of the efficacy of its current safety programs--the extent to which its safety programs are aligned with accident causes, and their effectiveness in mitigating these causes--as a baseline for guiding future safety initiatives.

The purpose of this study was to provide such a safety assessment. Specifically, it was the objective of this study to determine the extent to which the FAA safety programs were aligned against causes of air carrier accidents. As such, this study extends and refines a preliminary analysis made by FAA's Office of Aviation System Plans in 1976. This earlier study consisted of quantifying and allocating air carrier accident costs for the time period 1966-1975 to the probable causes of the accidents reported in the National Transportation Safety Board (NTSB) accident data base. The results suggested that such an assessment procedure constituted a practical and useful approach for safety program evaluation. However, the existence of several problems made it difficult to establish direct linkages between accident cause/factors and safety programs. For example, in some instances, accident cause/factor citations used by the NTSB dealt with symptomatic attributes of an accident; accounting for what occurred, but not explaining why the accident occurred. Further,

most accident records consisted of citations of multiple, related cause/factors. These multiple citations often contained redundancies and associated, but not causative, circumstances that are only spuriously related to the evaluation of safety program effectiveness.

The foregoing and other findings revealed in FAA's preliminary analysis of air carrier accident causes suggested data base and methodological requirements for the conduct of this study. Specifically, to successfully carry out this safety program evaluation, it was necessary to

a. Modify the NTSB accident cause/factor framework to facilitate proper alignment of accident causes and safety programs

b. Develop a comprehensive listing, description and categorization of FAA's safety programs to be used in the alignment analysis

c. Develop criteria and methodology for aligning safety programs and accident causes

d. Develop criteria and methodology for evaluating FAA's current safety programs and identifying needs for future safety programs and related activities.

This evaluation is based principally on assessments of the effectiveness of identified safety programs in mitigating the frequency of occurrence and associated costs of air carrier accidents. Toward this end, a study design was established in accord with the following specific objectives:

a. To identify safety programs that, singularly or in combination with other programs, are aligned with accident causes, are effective in mitigating these causes and whose continuation is warranted

b. To identify safety program needs including redirection of existing programs and description of program gaps associated with mitigation effectiveness and/or nonaligned accident causes

c. To determine overall safety program balance in terms of program priorities and resource commitments relative to the frequencies and costs of associated accident costs

d. To identify accident safety information needs that would facilitate continuing aviation safety program planning, analysis and evaluation.

The conclusions and recommendations of this study are subject to certain qualifications which should be identified. It is important to recognize the limitations of the data used in this study, especially when using the results of this study as a basis for adding or deleting specific safety programs. The principal qualifications that should be recognized in interpreting and using the results of the study are:

a. Air carrier accidents are rare events. They may not, therefore, accurately reflect the latent hazards in the system. Thus, high statistical confidence in causative inferences drawn from the analysis of such data is not possible.

b. The effectiveness of single programs should be considered in the context of other related programs, since the synergism between programs often enhances the effective mitigation of hazards.

c. Modified human error codes--cognition, decision and execution--were assigned on the basis of the use of the original NTSB human error codes in the accident records. In some cases where the accident report contained sketchy or incomplete data, assignment of the inferential codes was necessarily based on the best judgment of the investigators.

CONCLUSIONS

The conclusions of this safety program evaluation concern safety gaps, program balance, and future needs. These conclusions are summarized below for three major program areas: mechanical safety programs, environmental safety programs, and human error safety programs.

First, no substantive change is required with respect to mechanical safety programs. These programs effectively mitigate associated hazards, are balanced with respect to their coverage of the major cause/factor categories and have evolved over time into cohesive program clusters that effectively embody accumulations of technological knowledge.

Second, broader investigation into the integration of environmental programs with human factors programs is required if significant improvements in understanding weather cause/factor citations are to be achieved. Weather programs are balanced with respect to their coverage of cause/factors within this code classification category, are responsive to identified hazards and

address problems at appropriate levels in the accident cause hierarchy. In these respects, environmental programs parallel mechanical programs. However, the high citation frequency rate of weather cause/factors in conjunction with human error cause/factors suggests a lack of sufficient attention to the man-man, man-machine, and man-system interface. System level programs aimed at optimizing operator performance in specified temporal and spatial conditions are needed.

Third, new program initiatives are required that address human error problems in behavioral terms at detailed cause/factor levels. Such detailed programmatic efforts are needed as a knowledge base for existing, broader, programs (monitoring, standards, etc.) to be effective. To achieve further reduction in the air carrier accident rate, attention must be focused on investigating the human error causes in all aspects of the aviation system. All operators (pilot, crewmember, mechanic, air traffic controller, etc.) are now the leading cause of aircraft accidents. Their percentage of participation in all accidents has been steadily increasing over the study period. They are associated with at least 92 percent of deaths and 62 percent of total dollar loss in the last two years of the study.

RECOMMENDATIONS

Based on the findings and conclusions concerning safety program alignments and effectiveness, six recommendations have been made as a basis for further improvement in air carrier safety.

First, it is recommended that a basic human error research program be established. The objective of this program should be to understand why human operator errors occur. Such research should include field and laboratory data collection, modeling and experimentation. The results of these efforts should be used as a basis for determining operational programs dealing with subjects such as man-system interface, crew cockpit coordination/discipline and decision/execution/cognition error propagation.

Second, it is recommended that a program be established dealing with pilot/crew awareness training. The objective of this program should be to promulgate open communication and empirical feedback (and, hence, awareness) concerning reported pilot errors, explanations for their occurrence, associated

circumstances, and possible corrective actions. Such feedback is a vital attribute of successful safety programs.

Third, it is recommended that improvements be made in human factors and mechanical data gathering systems. The improvements should be aimed at solving technical problems in on-board monitoring systems (cockpit voice recorders and flight data recorders). Specific technical improvements needed include an independent power supply, microphone quality and placement, additional flight data and post-crash survivability.

Fourth, it is recommended that the NTSB re-examine its practice of citing probable cause. At present accident investigators cite only causes or factors that can be directly substantiated by observed facts. This practice accounts for use of human error descriptive codes as opposed to more explanatory, but inferential, behavioral codes. Yet, it is this latter type of information that is necessary for increased understanding of human operator problems. Additionally, accident investigators may cite up to ten causes and factors in an accident record; but the ADP record format precludes establishing the role of specific cause/factors in an accident based on their hierarchial structure and order of occurrence. Such information is important to the formulation of safety programs in terms of both their scope and approach to accident investigation.

Fifth, it is recommended that more formal means be established for collaboration with military research in aviation safety. Such collaboration should be of particular value with respect to experimental research in the area of pilot/crew decision, execution and cognition errors.

Sixth, it is recommended that a specific program be established to provide for pilot error reporting in accident and incident situations. The objective of this program should be to achieve on-line system feedback information in the human cause area analogous to that presently existing in the mechanical cause area. The information should be safeguarded and used only to build operator error profiles for better safety program definitions.

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CHAPTER 1.0 INTRODUCTION

This report provides an evaluation of the Federal Aviation Administration (FAA) safety programs with respect to the causes of air carrier accidents. This evaluation has been made in support of FAA planning aimed at improving safety in the National Aviation System (NAS).

In its responsibilities for maintaining and improving safety in the NAS, the FAA conducts safety research and development, installs facilities and equipment, provides operational procedures, and implements and enforces regulatory standards. These programs, in conjunction with aviation safety activities of other Government agencies and the aviation industry, have contributed to an impressive aviation safety record. Yet, accidents still occur resulting in loss of life and property damage. Further, the aviation environment is constantly changing, manifested by increasing traffic and congestion, more sophisticated equipment, more complex operational procedures, etc.--all imposing new demands for maintaining safety in future aviation activity. To meet these demands for maintaining aviation safety, the FAA recognizes the need for empirical assessments of the efficacy of its current safety programs--the extent to which its safety programs are aligned with accident causes, and their effectiveness in mitigating these causes--as a baseline for guiding future safety initiatives.

The purpose of this study was to provide such a safety assessment. Specifically, it was the objective of this study to determine the extent to which the FAA safety programs were aligned against causes of air carrier accidents. As such, this study extends and refines a preliminary analysis made by FAA's Office of Aviation System Plans in 1976. That earlier study consisted of quantifying and allocating air carrier accident costs for the time period 1966-1975 to the probable causes of the accidents reported in the National Transportation Safety Board (NTSB) accident data base. The results suggested that such an assessment procedure constituted a practical and useful approach for safety program evaluation. However, the existence of several problems made it difficult to establish direct linkages between accident cause/factors and safety programs. For example, in some instances,

NTSB accident cause/factor citations used by the NTSB dealt with symptomatic attributes of an accident; accounting for what occurred, but not explaining why the accident occurred. Further, most accident records consisted of citations of multiple, related cause/factors. These multiple citations often contained redundancies and associated, but not causative, circumstances that are only spuriously related to the evaluation of safety program effectiveness.

The foregoing and other findings revealed in FAA's preliminary analysis of air carrier accident causes suggested data base and methodological requirements for the conduct of this study. Specifically, to successfully carry out this safety program evaluation, it was necessary to

a. Modify the NTSB accident cause/factor framework to facilitate proper alignment of accident causes and safety programs

b. Develop a comprehensive listing, description and categorization of FAA's safety programs to be used in the alignment analysis

c. Develop criteria and methodology for aligning safety programs and accident causes

d. Develop criteria and methodology for evaluating FAA's current safety programs and identifying needs for future safety programs and related activities

The data bases, criteria, and methodology developed in accord with the above cited study requirements are described in Chapter 2.0 of this report. The analysis of the accident cause/factor data and evaluation of safety programs are given in Chapter 3.0. This chapter includes descriptive statistics of accident cause/factor frequencies of occurrence and associated costs for the time period from 1964 through 1976, alignment of frequently cited cause/factors with respect to the objectives of the FAA's safety programs, and evaluations of these safety programs in terms of effectiveness in mitigating the accident causes toward which they were directed. Chapter 4.0 contains the findings, conclusions and recommendations stemming from accident cause/factor-safety program analysis and evaluation described in Chapter 3.0. These study results are concerned with accident investigation data, air carrier accident histories, successful safety program profiles and categorical safety program effectiveness and needs with respect to mechanical, weather and human factors cause/factors.

STUDY OBJECTIVES

The overall objective of this study is to provide the FAA with an evaluation of its safety programs with respect to the causes of air carrier accidents. This evaluation is based principally on assessments of the effectiveness of identified safety programs in mitigating the frequency of occurrence and associated costs of air carrier accidents. Toward this end, a study design was established in accordance with the following specific objectives:

a. To identify safety programs that, singularly or in combination with other programs, are aligned with accident causes, are effective in mitigating these causes and whose continuation is warranted

b. To identify safety program needs including redirection of existing programs and description of program gaps associated with mitigation effectiveness and/or nonaligned accident causes

c. To determine overall safety program balance in terms of program priorities and resource commitements relative to the frequencies and costs of associated accident costs

d. To identify accident information needs that would facilitate continuing aviation safety program planning, analysis and evaluation.

As stated in the preceding section of this chapter, descriptive information and associated analyses pertinent to these objectives are given in Chapters 2.0 and 3.0 Recommendations concerning safety program and information needs are given in Chapter 4.0.

OVERVIEW OF STUDY SCOPE AND METHODOLOGY

The scope of this evaluation is bounded by the following factors. First, as specified previously in this chapter, accidents documented in the NTSB air carrier accident data base spanning the time period from 1964 through 1976 were examined. This data base consisted of a total of 800 accident records. General aviation accidents were not examined in this study. Second, the safety program alignment analysis was made with respect to cause/factors listed in the NTSB Manual of Code Classification (MCC)*. In some instances, modification of selected codes was determined to be necessary for purposes of the subject study. Third, the study included all FAA programs implemented during the same time period as the accident data base that either listed safety as the primary objective or as an important contributing objective. This program listing was compiled jointly by the FAA and Battelle and consisted of 90 separate safety programs. Fourth, the FAA provided Battelle a list of 21 "accident prevention measures" that were used in the accident analysis process. Specifically, in assessing each accident, a judgment was made regarding the possibility of having been able to prevent the accident if the prevention measure had been present.

To carry out the safety program-accident cause/factor evaluation, the sequential methodology shown in Figure 1-1 was developed and implemented. As shown in this figure, the methodology consisted of three parts.

a. Development of a modified cause/factor framework in terms of which the effectiveness of safety programs could be properly evaluated and the results validly interpreted. This modified framework entailed use of more explanatory cause/factor codes as substitutes for strictly descriptive codes and elimination of redundant and/or qualifying cause/factor citations that are used mainly to provide additional descriptive information related to an accident, but are not causes.

b. Determination of criteria and development of procedures for assessing alignment (or nonalignment) of safety program objectives and accident cause/factors, and analysis of the degree to which FAA's safety

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* Manual of Code Classification (MCC), June, 1970, Third Edition (Revised), National Transportation Safety Board, Washington, D.C.

STUDY ELEMENT	DATA BASE DEVELOPMENT	SAFETY PROGRAM AND CAUSE/FACTOR ALIGNMENT	SAFETY PROGRAM EVALUATION
DESCRIPTION	• Modify NTSB Cause/Factors to Facilitate Safety Program Evaluation • Define Accident Cost Elements • Identify, Classify and Define Safety Program Objectives • Categorize NTSB Safety Recommendations • Identify Facilities/Equipment Serving as Accident Preventors	• Aggregation of Low Frequency Cause/Factors • Establishment of Alignment Criteria • Application of Criteria in Aligning Programs with Cause/Factors	• Cause/Factor Frequency Changes Associated with Program Implementations • Combinational Program Effectiveness Based on Hierarchical Relationships Between Programs and Cause/Factors • Program Effectiveness Based on Approach to Accident Prevention
RESULTS	• Definition of Substitute Cause/Factor Codes • Deletion of Unessential Qualifying Cause/Factor Codes • Distribution of Accident Costs by Cause/Factor	• Direct Alignments • Indirect Alignments • Alignments with NTSB Safety Recommendations • Nonaligned Programs and Cause/Factors	• Overall Program Balance • Coverage/Gaps within Major Cause/Factor Categories • Recommended Initiatives

FIGURE 1-1. DESCRIPTION OF THE PRINCIPAL STUDY ELEMENTS AND INVESTIGATION SEQUENCE

programs mitigated the frequencies and costs of aligned cause/factors cited in air carrier accidents.

c. Determination of criteria and development of techniques for evaluating the overall effectiveness of FAA's safety programs. This evaluation included identification of attributes of successful programs, of relationships among programs that influenced their effectiveness, and the strengths and weaknesses in mechanical, weather, system, and human error categorical programs.

In the conduct of this research, literature reviews and interviews were used extensively in all phases of the analysis and evaluation effort. In particular, in the course of developing the accident cause/factor and safety program data bases and in carrying out the analyses of these data bases, frequent technical discussions were held with FAA's Office of Safety, Office of Flight Standards, Office of Aviation Medicine, and Systems Research and Development Service (in addition to the Office of Aviation Systems Plans); NTSB's Office of Accident Investigation and Office of Special Projects; and the NASA Ames Research Center, Aviation Safety Research Office.

QUALIFICATIONS IN INTERPRETING THE STUDY RESULTS

The findings and conclusions presented in the following chapters of this report are based on the analysis of the air carrier accident data base and supplemental information obtained through literature reviews and interviews with experienced professionals in the field of aviation safety. The findings and conclusions, and the resultant safety program recommendations which are presented are those which can be supported by the available data and information. It is important to recognize the limitations imposed by the nature and magnitude of the data used in this investigation; especially in making decisions to add or abandon any single safety program. The principal qualifications that should be recognized in interpreting and using the results of this study are summarized in the following paragraphs.

The empirical data used in the safety program-air carrier accident analysis are the frequencies of citation of cause/factors over the 13 year historical period from 1964 through 1976. In the 800 accidents that

occurred in this time period and were analyzed in this study, NTSB investigators cited 326 codes (of a possible list of 798 codes contained in the MCC) as accident causes. However, only 68 codes were cited six or more times. Using the modified cause/factor framework developed in this study, 27 codes were cited as cause as frequently as once per year, and only four codes were cited as cause five or more times per year. It is evident that air carrier accidents and their causes are rare events. It follows that high statistical confidence in inferences drawn from the analysis of such data is not possible. Moreover, the infrequent occurrence of most cause/factors makes it difficult to detect trends or shifts in rate of occurrence possibly attributable to safety program effects. Thus, in general, the effectiveness, or lack thereof, of a given program cannot be evaluated based strictly on statistical data. For example, a decision to abandon a program would not be warranted based strictly on infrequent citation of the cause toward which the program is directed. In all cases, the results of the analysis of observed accident data should be supplemented with engineering and operations experience in assessing hazards and in judging implied program needs.

A second caution in interpreting the study results is that the effectiveness of singular programs should be made in the context of other related programs. That is, it is the synergism among interconnected programs that often results in effective mitigation of hazards in the aviation system. This synergism is especially apparent in programs directed toward cause/factors in the mechanical category. The accident cause fault tree developed as an evaluation tool in this study has been used to display this interconnectivity among sets of safety programs.

Finally, in the modified cause/factor framework, the human error codes listed in the MCC have been aggregated under more explanatory codes; cognition, decision and execution. The decision to substitute these codes for the original NTSB cause/factor citations was made based on an intensive study of the original accident dockets. Valid use and interpretation of these substitute codes requires strict adherence to their definitions. For example, execution is defined to include both requisite skills by pilots/crews and their proper use in carrying out some action. Assignment of these modified codes based on information in an accident docket is inferential; i.e., cognition, decision or execution errors are not directly observable. The validity of these inferences, and,

hence, appropriateness of the substitute code uses, depends on careful reconstruction of pilot/crew actions in the accident event chain. In cases where the accident report contains sketchy or incomplete data, it is difficult to support valid assignment of these inferential codes. Thus, caution is required in properly making and interpreting substitute code assignments.

CHAPTER 2.0 DATA BASE AND METHODOLOGY

The data/information base developed for use in the evaluation of FAA's aviation safety programs consists of four parts

a. The NTSB air carrier accident data base (in particular, assignments of probable causes and contributing factors)

b. The costs of air carrier accidents including loss of life, injury and hull loss and damage

c. Descriptions of FAA aviation safety programs partitioned by functional category

d. An accident prevention measures list; facilities and equipment which had they been present,might have precluded accident events.

Correspondingly, a four-part methodology was developed for purposes of the subject analysis and evaluation. This methodology includes

a. Procedures for modifying the NTSB cause/factor framework to provide for proper alignment of safety programs and accident causes

b. A rationale and algorithm for determining accident costs and for distributing these costs among causes and factors cited in the accident records

c. Criteria for determining the degree of alignment between safety programs and related cause/factors

d. Criteria and procedures for evaluating the extent to which FAA's safety programs are effective in mitigating hazards in the National Aviation System.

These data base and methodological elements are described in detail in the following sections of this chapter.

THE AIR CARRIER ACCIDENT DATA BASE

The accident data base used in this study consisted of 800 air carrier accidents over the time period 1964 through 1976. This data base is maintained by the NTSB. Of the total of 800 records, probable cause could not be determined by NTSB investigators for 15 accidents and 25

accident records were not available for review. Thus, 760 records were finally used in the alignment analysis. The air carrier category includes all U.S. certificated route and supplemental air carriers.

THE ACCIDENT CAUSE/FACTOR FRAMEWORK

The NTSB Manual of Code Classifications (MCC) contains 15 major accident cause/factor categories which are subdivided into 70 specific cause/factor categories. These major categories and the number of subdivisions in each of them are listed in Table 2-1. Further, each of these 70 specific categories is subdivided into a varying number of codes describing specific actions, events or conditions associated with an accident. For example, the category, Pilot (64), contains 66 detailed actions for use in cause/factor coding and the category, Miscellaneous (84), contains 13 such codes. It is at this detailed code level of which there are 798 individual cause/factors, that the alignment of safety programs was undertaken.

An example of an accident brief on which this study is based is shown in Figure 2-1. The principal data fields of interest are enclosed in brackets in this figure. Codes cited as "probable causes" by NTSB investigators ("pilot in command misjudged distance and altitude" in this example) are verifiable actions or conditions that were determined to be directly accountable for an accident. Codes cited as "factors" (pilot in command-failed to follow approved procedures, etc.; miscellaneous acts, conditions-instrument misread or failed to read,....) are actions or conditions that further explain, supplement or qualify those codes assigned as "probable causes".

In determining the probable cause(s) of an accident, all facts, conditions, and circumstances are considered by investigators. The objective is to ascertain those cause-effect relationships that existed in the accident sequence. In those accidents in which more than one cause was determined to exist, all such causes were recorded. No attempt is made by the NTSB to establish a primary cause. Thus, there is no weighting of causes that would indicate their relative importance. The assignment of factors is treated in the same manner.

TABLE 2-1. MAJOR CAUSE/FACTOR CLASSIFICATIONS
(From NTSB Manual of Code Classification)

	Major Code Categories	Number of Major Subdivisions	Number of Individual C/Fs
Pilot	64	0	
Co-Pilot	65	0	66*
Dual Student	66	0	
Check Pilot	67	0	
Personnel	68	15	62
Airframe	70	4	42
Powerplants	74	31	237
Systems	75	10	74
Instruments/Equipment and Accessories	76	3	24
Rotorcraft	78	4	35
Airports/Airways Facilities	80	3	33
Weather	82	0	23
Terrain (other than airport)	83	0	11
Miscellaneous	84	0	13
Miscellaneous Acts, Conditions	88	0	178
Total	15	70	798

* Individual cause/factors are common to the four Major Code Categories, 64-67.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594
BRIEFS OF ACCIDENTS
U. S. AIR CARRIERS
ALL OPERATIONS
1974

FILE	DATE	AIRCRAFT DATA	INJURIES F S M/N
1-0001	1/30/74 PAGO PAGO. SAMOA. TIME - 2341	BOEING 707 N454PA DAMAGE-DESTROYED	CR- 10 0 0 PX- 86 5 0

NAME OF AIRPORT - PAGO PAGO INTL
OPERATOR - PAN AMERICAN WORLD AIRWAYS, INC.
DEPARTURE POINT — INTENDED DESTINATION — LAST ENROUTE STOP
AUCKLAND, NEW ZEALAND — LOS ANGELES, CALIF. — HONOLULU, HAWAII
TYPE OF ACCIDENT
UNDERSHOOT
COLLIDED WITH TREES

PHASE OF OPERATION
LANDING FINAL APPROACH
LANDING FINAL APPROACH

PROBABLE CAUSE(S)
PILOT IN COMMAND - MISJUDGED DISTANCE AND ALTITUDE
FACTOR(S)
PILOT IN COMMAND - FAILED TO FOLLOW APPROVED PROCEDURES. DIRECTIVES.PIC.
MISCELLANEOUS ACTS, CONDITIONS - INSTRUMENTS-MISREAD OR FAILED TO READ
MISCELLANEOUS ACTS, CONDITIONS - CREW COORDINATION-POOR
WEATHER - RAIN
PILOT IN COMMAND - SPATIAL DISORIENTATION
WEATHER BRIEFING - COMPANY DISPATCH
WEATHER FORECAST - UNKNOWN/NOT REPORTED

SKY CONDITION
BROKEN
VISIBILITY AT ACCIDENT SITE
1/2 MILE OR LESS
OBSTRUCTIONS TO VISION AT ACCIDENT SITE
NONE
WIND DIRECTION-DEGREES
20
TYPE OF WEATHER CONDITIONS
IFR
FIRE AFTER IMPACT
REMARKS - EXCESSIVE RATE OF DESCENT AFTR DH, VISUAL ILLUSTRATIONS PRODUCED BY ENVRNMNT, VASI APPARANTLY NOT USED.

FIGURE 2-1. EXAMPLE OF AN NTSB AIR CARRIER ACCIDENT BRIEF

Development of a Modified Cause/Factor Framework

The 1976 research study by the FAA directed toward preliminary alignment of safety programs and air carrier accident causes encountered several problems in using the existing NTSB cause/factor framework. In general, it was found that cause/factor citations often were not sufficiently specific or explanatory for purposes of safety program alignment. This lack of specificity was especially prevelant in the case of cause/factors in the pilot/crew categories (codes 64-67). Further, it was found that cause/factor citations in some instances could not be interpreted unambiguously with respect to the chain of events involved in an accident sequence. This problem stemmed principally from the citation of multiple causes and/or factors without any reference to the hierarchical relationships among them. Accordingly, as a prerequisite to the alignment analysis and safety program evaluation made in this study, initial effort was focused on defining and resolving problems in the use of the NTSB cause/factor framework in serving the objectives of this study. The means by which these problems were identified and addressed, the findings,and the resultant modifications made in the NTSB cause/factor framework relevant to this study are described in the following paragraphs.

Analysis of Requirements for Modifying the Cause/Factor Framework. A three-part procedure was used in identifying specific requirements for modifying the cause/factor framework to better facilitate the safety program analysis. These three parts consisted of

a. Preparation of logic diagrams of accident event sequences and evaluation of cause/factor suitability for program alignment

b. Determination of cause/factor assignment rationales used by NTSB accident investigators

c. Detailed examination of accident dockets involving cause/factor citations in the pilot/crew categories.

Accident Sequence Diagramming and Cause/Factor Alignment Suitability. The accident cause/factors listed in the NTSB's MCC were examined individually according to the screening logic shown in Figure 2.2. The intent of this screening logic was to identify those cause/factors that were sufficiently well-defined but were not used in a manner that facilitated valid cause-effect alignments with existing FAA safety programs. Cause/factors that were found to be well-defined, but having no alignment with an existing FAA program, were further evaluated with respect to the feasibility of postulating a hypothetical safety program based on the information implied in the accident cause/factor citations. In those instances where cause/factors were judged to be unsuitable for the purpose of safety program alignment, acceptable modifications were sought in the form of disaggregates of or substitutes for existing cause/factors. As shown in Figure 2-2, the identification of acceptable modifications was based first on the possible use of cause/factors in the miscellaneous acts, conditions category (code 88) as disaggregates; then on the possible use of incident enabling and associated factors contained in the Aviation Safety Reporting System* (ASRS) lexicon as disaggregates or substitutes; and finally on the determination of substitutes based on detailed examination of the air carrier accident dockets. The last approach is described in the following section of this report.

In exercising the cause/factor suitability screening process described above, cause/factor hierarchical event chains were constructed for a sample of accidents. These event chains, drawn in fault tree format, portrayed the hierarchy (where it existed) among cause/factors cited in the accident record. The partial event chain shown in Figure 2-3 illustrates the hierarchial relationships between the accident type, "overshoot" and the cause/factor "delay in initiating go around". Alignment of safety programs was made

* The Aviation Safety Reporting System (ASRS) is a voluntary incident reporting system managed by NASA Ames Research Center for the FAA, and operated by Battelle Columbus Laboratories. A lexicon of "enabling" and "associated" factors was developed for use in encoding reporting incidents. The use of these factors is analogous to that of "cause" and "factors", respectively, listed in MCC and used by NTSB accident investigators.

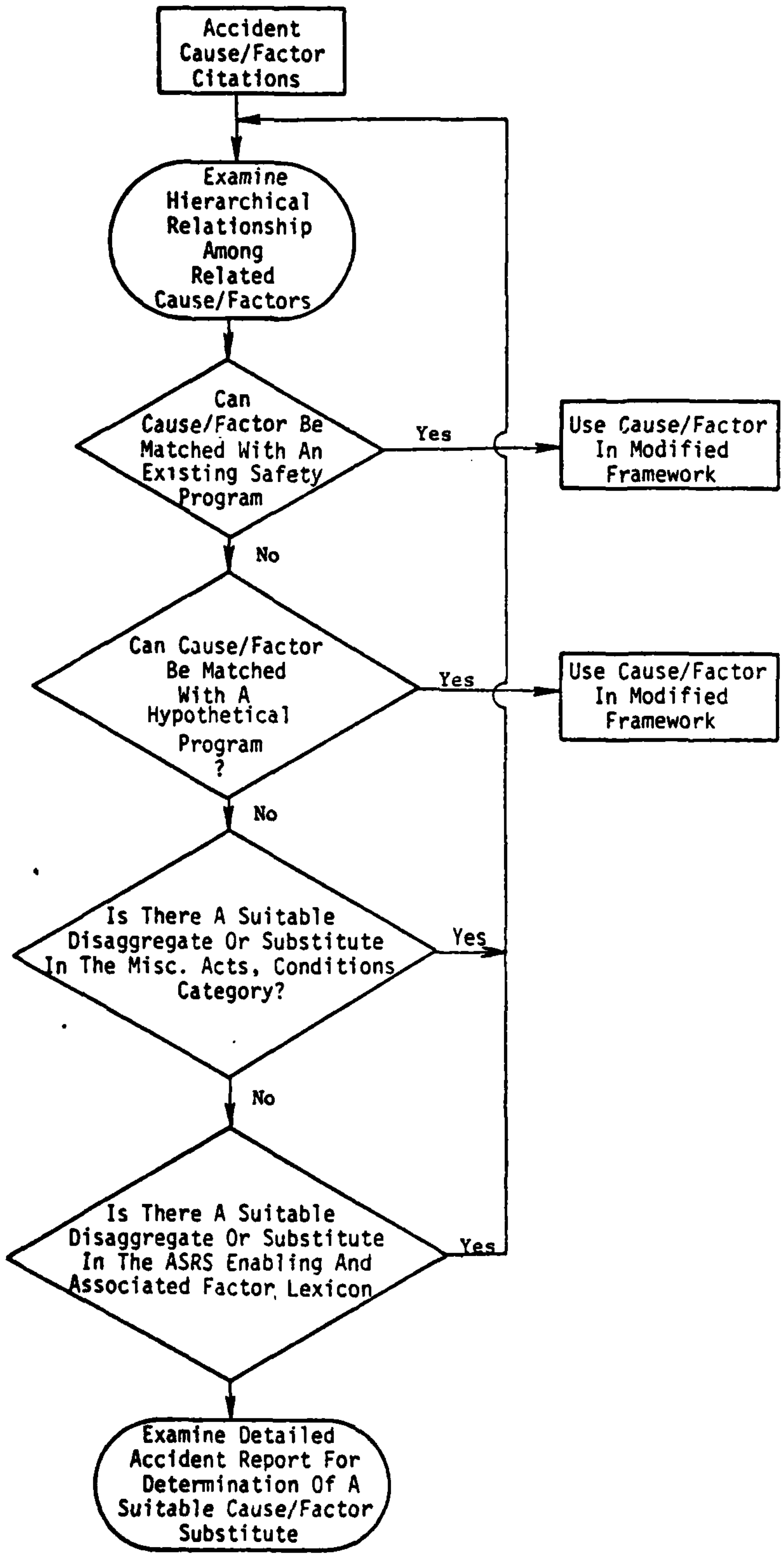

FIGURE 2-2. DIAGRAMMATIC REPRESENTATION OF THE ACCIDENT CAUSE/FACTOR SUITABILITY SCREENING PROCESS

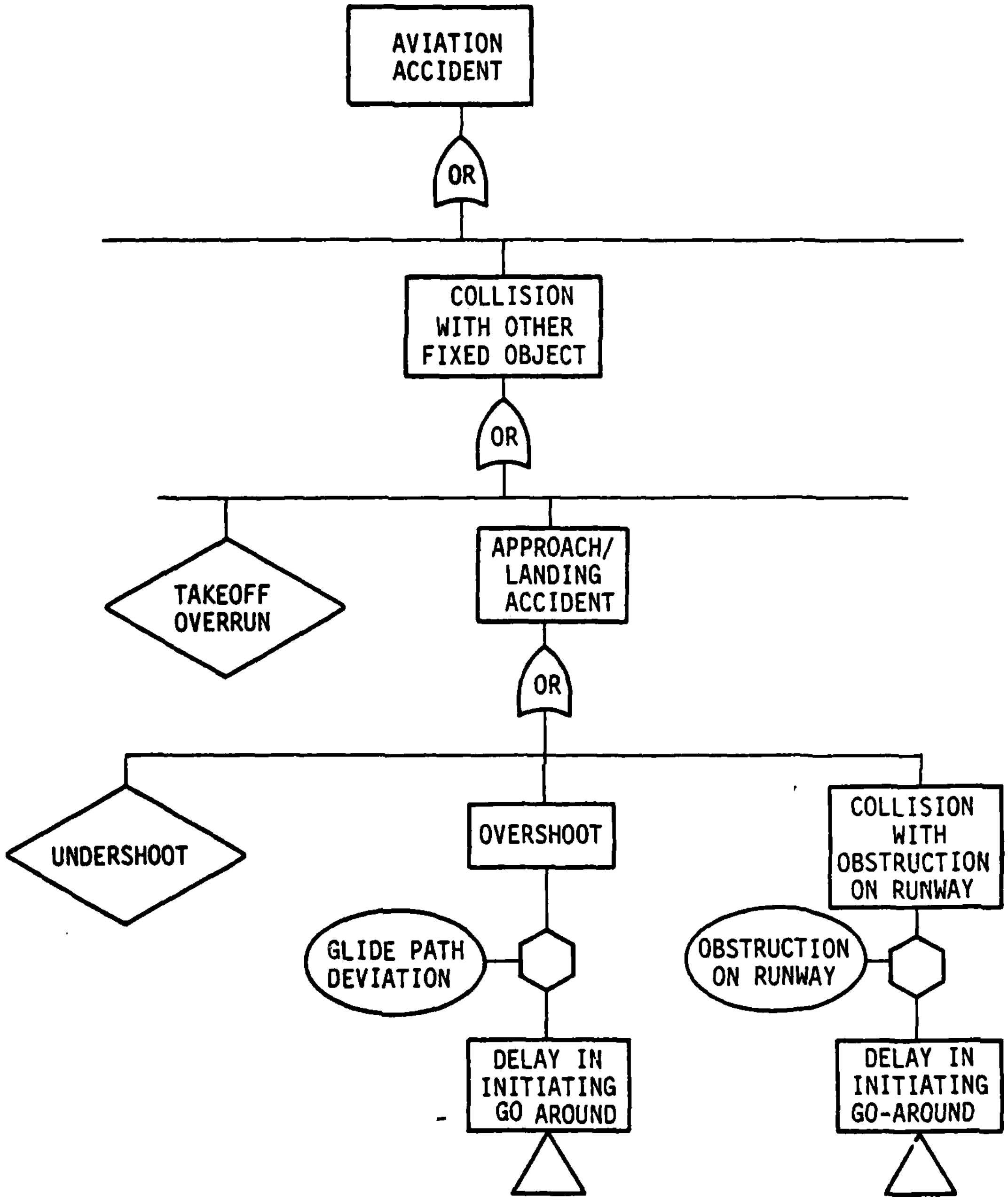

FIGURE 2-3. DIAGRAM OF A PARTIAL CAUSE/ FACTOR EVENT CHAIN

where possible, at the lowest level of this cause/factor event chain. Use of this approach helped to resolve problems associated with aligning multiple, related cause/factors with corresponding safety programs, and provided a basis for subsequent determination of acceptable cause/factor modifications, where required.

The findings of this cause/factor suitability evaluation with respect to safety program alignment are as follows:

a. All cause/factors in the Mechanical categories (codes 70, 74, 75, 76, 78) could be used as defined in the MCC for purposes of alignment analysis. The level of detail represented by mechanical cause/factors provided for establishing direct connections to the objectives of FAA safety programs designed to mitigate mechanical failures.

b. All cause/factors in the Weather category (code 82) could be used as defined in the MCC for purposes of alignment analysis. Again, strong alignment was found between the weather cause/factors and FAA safety programs designed to mitigate weather-related accidents.

c. The major cause/factor Airports/Airways (code 80), Terrain (code 83), Miscellaneous (code 84), are well-defined for purposes of logical structuring of accident event sequences with respect to related environmental conditions or facilities. These categories contain descriptors of conditions or facilities present at the time of an accident. They are not generally directly pertinent to determination of accident cause-effect relationships.

d. All cause/factors in the Miscellaneous Acts, Conditions category (code 88) are sufficiently well-defined for purposes of identifying their roles in accident cause-effect relationships. However, these cause/factors are commonly assigned by accident investigators for purposes of qualifying the circumstances in the accident event sequence. Alignment of safety programs with these cause/factors, given this common usage, would likely lead to inappropriate identification of safety program needs concerning accident related, but not causative factors.

e. All cause/factors in the Personnel category (code 68) could be used as defined in the MCC for purposes of alignment analysis. Again, as in the cases of mechanical and weather cause/factors, monitoring and regulatory programs could be established.

f. Cause/factors in the Pilot/Crew categories (codes 64-67) were judged to be generally too uninformative for use in safety program alignment and evaluation. The principal determinant here is that the cause/factors describe what happened in an accident sequence, but do not reveal why. In general, NTSB air carrier accident investigations are constrained to uncovering those observable facts prevailing at the time of the accident. For most cause/factor categories (mechanical, weather, airport/airways, etc.) such an approach is generally sufficient. However, in the pilot/crew category the investigative detail tends to be lacking in terms of behavioral explanatory information. It is this latter type of information that is required to establish safety programs that address fundamental hazards rather than symptomatic conditions.

Modifications of Cause/Factor Citations in the NTSB Air Carrier Accident Records. Based on the findings described in the preceding Section, four requirements for modification of cause/factor citations in the air carrier accident records were identified. These requirements are:

a. Elimination of noninformative duplications associated with multiple, related cause/factor citations. This requirement stems from the use of additional cause/factor citations to provide supplementary descriptive information and/or to qualify primary cause/factor citations

b. Reduction in redundancy associated with the use of explanatory cause/effect event chains, especially in the mechanical cause/factor categories. Such redundancies constitute double counting of the same accident causes

c. Elimination of cause/factor citations in the personnel category (code 68) in accidents where the indicated personnel are receivers (not the cause) of an action, rather than the doers (the cause) of an action

d. Establishment of more explanatory cause/factor codes in the pilot/crew categories (codes 64-67) as substitutes for existing codes in the MCC that are essentially event descriptors

Implementation of these modification requirements was based on examination of selected accident reports and on the results of interviews with safety specialists at the NTSB, FAA and NASA. Specifically, 351 accident records (from the population of 800 records) were selected for detailed examination, as shown in Table 2-2. All accident reports expected to contain information

TABLE 2-2. ACCIDENT RECORDS SELECTED FOR DETAILED EXAMINATION

Population of Accident Records		800
Accident Records Not Examined		449
Undetermined Cause	15	
Mechanical Only, No Human Cause	222	
Seat Belt Related Accidents	187	
Records Unavailable at NTSB	25	
Accident Records Examined		351

pertinent to the above stated requirements were examined. Accidents involving strictly mechanical causes and seat belt related accidents were excluded from this selection. Accidents, the causes of which were mechanical, were eliminated for two reasons. First, because of the high level of technological aircraft autopsies made by NTSB investigators, detailed causes can be firmly established in virtually all cases. Second, given no human error cause/factors, there were no ambiguities in the accident event sequence. Moreover, these reports contain no information pertinent to identifying pilot/crew cause/factor substitutes. With respect to the latter exclusion, those cited as a "seat belt accident" were not selected for further review (with FAA concurrence) because no cause/factor modifications were required in order to facilitate the safety

program evaluation. Finally, 40 accident records were not examined because they were either unavailable or were of undetermined cause.

Concurrent with the detailed records examination, technical discussions were held with safety specialists in the NTSB Office of Accident Investigation and the Office of Special Projects, the FAA Office of Aviation Medicine and the Flight Standards Service, and the NASA Office of Aviation Safety Research. These discussions centered on

a. Common practices of NTSB investigators in assigning cause/factor codes in the terrain, miscellaneous, and miscellaneous acts and conditions categories (codes 83, 84 and 88, respectively); how these codes are used with respect to determinations of probable cause, and how they should be interpreted with respect to safety program needs and effectiveness

b. Identification of human error codes that better explain causal behavior and can be reasonably verified based on information contained in the detailed accident reports.

Based on the records examination and discussions described above, modifications were made in the citation of cause/factors in the accident data base as described in the following paragraphs.

<u>Cause/Factors Used As Qualifiers or Supplemental Descriptors</u>. The use of terrain (code 83) and miscellaneous acts, conditions (code 88) as adjectives, qualifiers, and descriptive phrases by NTSB investigators is common practice and is sometimes necessary in conveying all of the relevant circumstances of an accident to users of the accident reports. An example of this practice is illustrated by the coding of an accident that occurred in Fort Worth, Texas. The cause/factor codes cited by NTSB investigators in this instance were:

64A22, 70ACL, 68AD6, 88J55, 88JBA, 88J18, 88J27.

These codes are defined as:

64A22 - Pilot operated brakes improperly
70ACL - Landing gear warning and indicating components
68AD6 - Maintenance Personnel - inadequate maintenance or inspection
88J55 - corroded/corrosion

88JBA - Binding

88J18 - Dumped fuel

88J27 - Landed on foamed runway.

In this case, it is seen that the miscellaneous acts, conditions, cause/factors (code 88) themselves are not the responsible causes or factors in the accident. To retain these cause/factor codes in the alignment analysis would lead to confusing conclusions concerning safety program gaps, and hence, apparent needs.

It has been acknowledged by NTSB experts that deletion of these types of cause/factors, used in the manner illustrated above, would not change the essential findings of probable cause. Given this recognition by the NTSB, and to eliminate problems that would otherwise arise with program alignments against qualifying cause/factor citations, the modified cause/factor framework does not contain any cause/factors associated with terrain (codes 83) or miscellaneous acts, conditions (code 88) of the MCC. Removal of these cause/factors resolved about 98 percent of the problem of duplication. Only a few citations of possibly duplicative cause/factors remain scattered among the 13 major cause categories retained in the modified cause/factor framework.

<u>Partially Redundant Cause/Factor Chains in the Mechanical Category</u>. In some instances, accident investigators will cite multiple cause/factors that define a single cause-effect event chain. This practice is especially prevalent in accidents involving mechanical failure. For example, the encoding of an accident in which mechanical failure is the primary cause might include the cause/factor citations:

74CAC, 74CAD, 88C95

where

74CAC = Wing attachment fitting bolts

74CAD = Bracing wire, struts

88C95 = Material failure

It is evident that these cause/factor citations describe a physical cause-effect sequence in which an initial failure, 74CAC relates to a second failure, 74CAD, which in turn might be caused by a third, and accident producing failure, 88C95. That is, the cited cause/factors are clearly related, although the hierarchial relationship is not explicitly established in the accident encoding.

As discussed in the previous section, this is also another case of using a Code 88 descriptor as an accident cause citation.

This practice in encoding some accidents involving mechanical failures represents no inherent problem in the existing cause/factor framework or in its use. The degree of explanatory detail is high and the redundancy is clear. However, distributing the costs associated with an accident (the cost distribution method is described in the following section of this report) among partially redundant cause/factors could lead to inappropriate conclusions concerning the severity of individual cause/factors. Accordingly, given the above description of the redundancy problem, no change has been made in the cause/factor framework. But, it is important to recognize that cause/factor and associated accident cost comparisons should be interpreted carefully because of the potential double counting inherent in this encoding redundancy practice.

Personnel Cause/Factor Citations. Cause/factor citations in the personnel category (code 68) are sometimes misleading in that the personnel cited may be either the doer of an action (cause) or the receiver of an action (non-cause). In cases in which the cited personnel is a recipient (not the cause) of the resultant action, it would be inappropriate to interpret the cited cause as one toward which a safety program should be directed. For example, a flight attendant might be cited as being at fault in an accident in which the seat belt light was turned on, but a passenger (who is included under code 68) who does not have his seat belt on incurred an injury. An accident of this nature is subject to ambiguous interpretation: was the flight attendant at fault (cause) for not properly ensuring that the passenger (non-cause) complied with cabin safety rules, or did the flight attendant take reasonable action to check passenger seat belts (non-cause), and, hence, the passenger was at fault (cause)?

As in the case of cause/factor redundancy, there appears to be no basis for modifying the cause/factor framework to rectify this ambiguity. Rather, this situation further implies the need for caution in judging the relative severity of individual cause/factors based strictly on their rates of occurrence. What is important in evaluating this cause category is that regardless of "fault" assignment, this type of accident continues to occur at a high frequency.

Substitute Cause/Factors for Pilot Error Citations. As stated in the findings of the initial determination of cause/factor suitability, any attempt to disaggregate the 66 cause/factors in the pilot/crew categories (codes 64-67) would only result in a more refined description of what happened in an accident, rather than a behavioral explanation of why it happened. Thus, it was required to convert the cause/factors in these categories of the NTSB MCC into a more appropriate form. This conversion was required not only to facilitate useful safety program evaluations, but also to identify those areas of human behavior research vital to future accident prevention programs that reach beyond symptomatic treatment of accident descriptors.

Three human error cause/factor substitutes were chosen in accord with this requirement. Those substitutes, which appear to be the most widely accepted among behavioral theorists, are decision, execution, and cognition. These substitute codes are defined as follows:

Decision Error. The decision error represents behavior that can be inferred from an accident as a bad judgement, a poor choice among alternatives available or the failure to take an action. The underlying causes of a decision error, in general, can only be conjectured based on accident data, but cannot be empirically verified.

Execution Error. The inference of an execution error denotes the apparent absence of skill or technique resulting in an accident. Citation of an execution error does not necessarily establish that the pilot/crew did not have the requisite capabilities but that they might have failed to use them, or used them inappropriately.

Cognition Error. The cognition error represents the failure to seek or to use available data necessary in the decision making process. Cognition also includes the "false hypothesis", i.e., believing something is correct and continuing to act on it in the face of conflicting, accurate information.

It is important to realize that valid substitution of the above human factor codes for those cited in the accident reports is difficult. For example, a weakness inherent in making such substitutions in the aircraft accident records is that what was inferred to be an execution error might have been based on a pilot's rational decision stemming from a false hypothesis (cognition error). The accident investigation reports are to some degree ambiguous as to which might have been the real cause. It is believed that the principal result achieved by this redefining of human error is a closer focus on the major types of error occurring in the air carrier industry. These three major cause/factor substitutes cover the entire list of MCC pilot error codes with the exception of physical impairment. The latter is retained as is in the modified cause/factor framework. The code modifications offer several advantages for the purposes of this study. First, these codes consolidate human errors under definitions that can be readily related to several conceptual models of human behavior. Second, these codes result in a higher degree of alignment with the current FAA safety programs and eliminate the need to postulate a plethora of programs, each aimed at resolving rarely occurring symptoms. Finally, these human error categories are recognizable, if not always observable events, that are common to most aircraft accidents and could be detected in an investigation.

The Modified Cause/Factor Framework. The major Code Categories of the NTSB's Manual of Code Clasifications (MCC) that were retained for the modified cause/factor framework are shown in Table 2-3.

TABLE 2-3. MAJOR CAUSE/FACTOR CATEGORIES RETAINED IN THE MODIFIED FRAMEWORK

MCC Major Codes	Descriptions of Cause/Factor Types
64, 65, 66, 67	Pilot/crew
68	Personnel
70, 74, 75, 76, 78	Mechanical
80	Airport/airways facilities
82	Weather
84	Miscellaneous

The two major cause/factor categories that were eliminated were terrain (code 83) and miscellaneous acts and conditions (code 88). The two major cause/factor code categories that required modification were the pilot/crew cause/factors (codes 64-67) and the weather cause/factors (code 82). These latter cause/factor modifications were made to eliminate unessential redundancy, and concommitantly, misleading results in accident cost distribution. Specifically, code 82*A (low ceiling) is deleted when cited in conjunction with code 82*C (fog), and code 82*X (thunderstorm activity) is deleted when cited in conjunction with code 82*L (turbulence in flight associated with clouds, thunderstorms). The individual cause/factors in the modified cause/factor framework are summarized in Table 2-4.

The 66 cause/factors listed in NTSB's MCC under pilot/crew error were converted into four new cause/factors. These conversion codes are shown in Table 2-5. The description of these NTSB MCC pilot/crew cause/factors is shown in Table 2-6. The substitution correspondence between the pilot/crew cause/factor codes listed in the MCC and the study's modified codes is shown in Table 2-7. As described in the preceding section, the conversion of these 66 cause/factors was based on thorough review of the 351 accident records. Further, the selection and placement of the substitute cause/factors is consistent with human factors research being conducted by the NASA Ames Research Center in connection with the Aviation Safety Reporting System (ASRS).

Rules for Changing Accident Records in Accord with Cause/Factor Framework. Application of the modified cause/factor framework in encoding accident records was carried out in accord with uniform consistency rules given below for two reasons. First, it was the intent of this study to maintain the integrity of the NTSB's investigation and their findings for the assignment of probable cause in an accident. That is, no attempt has been made to reinvestigate or second guess the rationales for cause/factor assignments made by the NTSB. Second, it was essential to consistently modify the cause/factor lexicon so that the evaluation of FAA safety programs could be interpreted on a uniform basis with respect to the cause/factors and costs against which they were aligned. These rules evolved from numerous discussions between the project investigators, the FAA, and the NTSB. As such, they constitute a consensus of the three.

TABLE 2-4. MAJOR CAUSE/FACTOR CLASSIFICATIONS IN THE MODIFIED CAUSE/FACTORS FRAMEWORK

	Major Code Categories	Number of Major Subdivisions	Number of Individual C/Fs
Pilot	64	0	
Co-Pilot	65	0	4*
Dual Student	66	0	
Check Pilot	67	0	
Personnel	68	15	62
Airframe	70	4	42
Powerplants	74	31	237
Systems	75	10	74
Instruments/Equipment and Accessories	76	3	24
Rotorcraft	78	4	35
Airports/Airways Facilities	80	3	33
Weather	82	0	23
Miscellaneous	84	0	13
Total	13	60	547

* Individual C/Fs are common to the four Major Code Categories, 64-67.

TABLE 2.5. INDENTIFIERS AND CODES FOR THE SUBSTITUTE PILOT/ CREW CAUSE/FACTORS IN THE MODIFIED FRAMEWORK

Pilot/Crew Error Identifier	Study Code Description
Decision	64*01
Execution	64*02
Cognition	64*03
Physical Impairment	64*04

TABLE 2.6. IDENTIFIERS OF PILOT CAUSE/FACTOR CODES FROM NTSB MANUAL OF CODE CLASSIFICATION *

Code	Cause/Factor Description*
01	Attempted operation with known deficiencies in equipment.
02	Attempted operation beyond experience/ability level.
03	Became lost/disoriented.
04	Continued VFR flight into adverse weather conditions.
05	Continued flight into known area of severe turbulence.
06	Delayed action in aborting takeoff. (See code 81)
07	Delayed in initiating go-around. (see code 82)
08	Diverted attention from operation of aircraft.
09	Exceeded designed stress limits of aircraft.
10	Failed to extend landing gear.
11	Failed to retract landing gear.
12	Retracted gear prematurely.
13	Inadvertently retracted gear.
14	Failed to see and avoid other aircraft.
15	Failed to see and avoid objects or obstructions.
16	Failed to obtain/maintain flying speed.
17	Misjudged distance, speed, altitude or clearance.
18	Failed to maintain adequate rotor r.p.m. (helicopters).
19	Failed to use or incorrectly use miscellaneous equipment.
20	Failed to follow approved procedures, directives, instructions, etc.
21	Improper operation of Powerplant controls. (Includes propeller controls.)
22	Improper operation of brakes and/or flight controls.
23	Improper operation of flight controls.
24	Premature lift-off.
25	Improper level off.
26	Improper IFR operation.
27	Improper in-flight decisions or planning.
28	Improper compensation for wind conditions.
29	Inadequate preflight preparation and/or planning.
30	Inadequate supervision of flight.
31	Lack of familiarity with aircraft.
32	Mismanagement of fuel.
33	Exercised poor judgment.
34	Operated carelessly (neglect, forgetfulness).
35	Selected unsuitable terrain.
36	Improper starting procedures.
37	Started engine without proper assistance and/or equipment.
38	Taxied/parked without proper assistance.
39	Failed to assure the gear was down and locked.
40	Initiated flight in adverse weather conditions.
42	Failure to relinquish control.
43	Control interference.
44	Spontaneous - improper action.
45	Misjudged distance, speed, and altitude.

* Major Code Categories: 64 (pilot in command); 65 (copilot); 66 (dual student) and 67 (check pilot)

Table 2-6. - Continued

Code	Cause/Factor Description*
46	Misjudged distance and speed.
47	Misjudged distance.
48	Misjudged distance and altitude.
49	Misjudged speed and altitude.
50	Misjudged speed.
51	Misjudged speed and clearance.
52	Misjudged altitude and clearance.
53	Misjudged altitude.
54	Misjudged clearance.
55	Inadequate training of student (instructor in airplane)
56	Misunderstanding of orders or instructions.
62	Improper recovery from bounced landing.
64	Incapacitation
65	Physical Impairment
66	Spatial disorientation.
67	Psychological condition.
71	Misused or failed to use flaps.
74	Left aircraft unattended, engine running.
79	Failed to maintain directional control.
80	Selected wrong runway relative to existing wind.
81	Failed to abort takeoff. (See code 06)
82	Failed to initiate go-around. (See code 07)

* Major codes categories: 64 (pilot in command); 65 (copilot); 66 (dual student) and 67 (check pilot).

TABLE 2-7. PLACEMENT OF THE 66 PILOT/CREW C/Fs IN THE MCC WITH RESPECT TO THE MODIFIED, SUBSTITUTE CODES (Codes from MCC)

Study Substitute Codes				
Decision (-01)	Execution (-02)	Cognition (-03)	Physical Impairment (-04)	Eliminated (Not C/Fs)
		MCC Codes		
-01	-08	-03	-64	-43
-02	-09	-14	-65	-67
-04	-10	-15	-66	
-05	-11	-31		
-06	-12	-56		
-07	-13			
-20	-16			
-27	-17			
-29	-18			
-30	-19			
-33	-21			
-34	-22			
-37	-23			
-38	-24			
-40	-25			
-42	-26			
-74	-28			
-80	-32			
-81	-35			
	-36			
	-39			
	-44			
	45-55			
	-62			
	-71			
	-79			
	-82			

Rule 1. <u>If it is judged necessary to modify a specific cause/factor in any single case, the cause/factor will be identically modified in all cases in which it is cited</u>.

This rule ensures logical consistency in the allocation of accident costs against cause/factors and alignment of safety programs with cause/factors.

Rule 2. <u>All pilot error cause/factor codes, with the exception of those associated with physical impairment (codes 64, 65, 66, 67) are replaced by the substitute codes; Execution, Decision, and Cognition</u>.

Use of these human factors substitutes was judged to be suitable in eliminating lack of specificity in "Pilot" cause/factors (e.g., "failed to follow prescribed procedures...") and to facilitate safety program alignment in the areas of training, education, certification and regulatory enforcement. Further, these substitutes facilitated identification of safety program needs and options in relation to the results of extensive human factors research. The exception to this rule is that the human error cause/factor "physical incapacitation" remained unchanged in the modified cause/factors list.

Rule 3. <u>Cause/factor substitutions are made on a one-for-one basis, regardless of the number of appearances of the cause/factor in an accident citation listing</u>.

This rule was necessary to reduce the redundancy and ambiguity in the cause/factor safety program alignment, while retaining the cause/factor cost alignment of the specific incident.

Rule 4. <u>Any cause factor listed in the NTSB's Manual of Code Classification (MCC) that is used solely as a qualifier, adjective, or a descriptive phrase will be deleted from the modified accident record</u>.

It was confirmed by NTSB that a large number of the cause/factors listed in the MCC were used solely for the purpose of explaining in greater detail a single cited cause. These cause/factors, the majority of which were contained in NTSB cause category "Miscellaneous Acts and Conditions" (Code 88), were removed from the final modified cause/factor list. Thus, accident costs are assigned to the most direct cause, and not diluted or distributed among factors used strictly to provide supplemental information.

ACCIDENT COSTS

In the antecedent study to this investigation made by FAA's Office of Aviation System Plans, accident costs were determined for all accidents in the NTSB air carrier data base for the years from 1966 through 1975. These costs consisted of:

a. value of loss of life
b. personal injury
c. aircraft hull loss and damage

These cost elements and the bases for their determination are summarized in the following paragraphs. The following section describes the procedure that has been used in distributing an accident cost among the cause/factors associated with the accident.

Determination of Accident Cost Elements

Value of Loss of Life. Several theoretical and empirical methods have been used in estimating the value of human life. Methods considered in the above referenced antecedent study include the present value of a typical passenger's expected future earnings; maximization of the present value of a passenger's future lifetime utility stream; passenger utility maximization plus value to family, community, employer, Government and airlines; average judicial settlements over the 1964 to 1974 time period; and CAB data based on non-Warsaw Pact payments during the 1966-1970 period (extrapolated) to 1974. For a typical airline passenger*, the values of life (in 1974 dollars) obtained by applying the respective methods stated above are given in Table 2-8.

The value of human life used as a cost element in this study, as in the antecedent study, is $300,000. As stated in the antecedent study, "this figure was chosen because it reaches a compromise between the theoretical constructs...and the actual cost figure of $195,000 derived from the Civil Aeronautics Board (CAB) data on non-Warsaw Settlements."

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* The typical airline passenger is described as being 40 years of age, has an income of $24,000 (in 1974 dollars), and increases his income at an annual rate of 2.5 percent for the next 25 years.

TABLE 2.8. ESTIMATED VALUE OF LIFE OF A TYPICAL AIRLINE PASSENGER BASED ON SELECTED METHODS OF ESTIMATION

Method of Valuation of Human Life	Estimated Value (1974 dollars)
Future Earnings Present Value	$300,000
Future Maximum Utility Present Value	$200,000
Future Maximum Utility Present Value plus Value to Others	$1,000,000
Judicial Settlements (1964-1974)	$195,000
Non-Warsaw Pact Payments (CAB Data 1966-1970, extrapolated)	$300,000

Cost of Personal Injury. Costs of personal injury, both major and minor, have been determined based on CAB data on non-Warsaw average settlements. Extrapolating these average settlement payments to 1974, it is estimated that the cost of a major injury is $45,000 and the cost of a minor injury is $6,000.

Cost of Hull Loss and Damage. The cost estimates used for destroyed aircraft is assumed to be the equivalent average selling price of an identical make and model of aircraft in the year of the accident. No adjustments have been made to account for special electronics or other equipment.

With respect to "substantial hull damage", repair costs are estimated to be one-third of the cost of a replacement aircraft. As stated in the antecedent study, this value is generally accepted in the aviation industry. The industry also generally supports the assumption that repair costs for "minor damage" are negligible.

The accident cost elements described above, and used in this study, are summarized in Table 2.9.

Distribution of Accident Costs Among Cause/Factors.

The cost elements described in the preceding section have been used in accident valuations for the 800 accidents in the air carrier data base. As one means of measuring the relative severity of individual cause/factors, each

TABLE 2-9. COST ELEMENTS USED IN THE VALUATION OF AIR CARRIER ACCIDENTS

Cost Element	Valuation (1974 dollars)
Loss of Life	$300,000
Personal Injury	
Major	45,000
Minor	6,000
Loss of Hull	Identical Used Aircraft Average Selling Price at Time of Accident
Hull Damage	
Substantial	One-Third of Replacement Cost
Minor	Negligible

total accident cost was apportioned among the causes and factors contributing to the accident. In making the apportionment, the relative valuation of causes and factors were weighted in a ratio of 4 to 1. That is, for example, in an accident involving citation of one cause and one factor, 80 percent of the accident cost would be attributed to the cause, and 20 percent attributed to the factor. In general, the accident cost apportionment among causes and factors is, respectively:

$$\text{Cost of Each Cause} = \frac{4 \times \text{total accident cost}}{4 \times \text{number of causes} + \text{number of factors}},$$

$$\text{Cost of Each Factor} = \frac{\text{Total Accident Cost}}{4 \times \text{number of causes} + \text{number of factors}}$$

This ratio formula was developed in the antecedent study based on discussions with NTSB and FAA experts. Sensitivity tests using 3 to 1 and 5 to 1 ratios showed no significant differences in relative cost comparisons.

Redistribution of Accident Costs for the Modified Accident Records. The air carrier accident data base encoded in accord with the modified cause/ factor framework entails substitution of new cause/factors for those listed in the MCC for the pilot/crew categories (codes 64-67), and deletion of cause/ factors in the terrain (code 83) and miscellaneous acts, conditions category (code 88) where they are cited in each accident record. These substitutions and deletions require redistribution of the total cost of an accident among the cause/factor citations as modified. This redistribution is made in accord with the procedure described in the preceding paragraph. In so doing, the total dollar loss for each accident remains unchanged. Where a cause/factor is deleted from an accident, its apportioned share of the accident cost is redistributed among the remaining cause/factors in that specific record. Analagously, where a cause/factor substitution is made, the substitute cause/factor code automatically assumes that cost apportioned to the cause/ factor for which the substitution was made. It is noted that one substitute cause/factor may be substituted more than once in a single record. For example, in an accident record, the original citations of "improper operation of flight controls" (64*23) and "misjudged distance, speed or altitude" (64*45), would be substituted twice by the modified cause/factor "execution error" (64*02). In this instance, the substitute cause/factor, "execution error", would assume the costs apportioned to both of the originally cited cause/factors.

A complete example illustrating how all accident costs were distributed among cause/factors in the original record, and then redistributed among cause/factors in the modified record is given in Figure 2-4.

THE SAFETY PROGRAM INFORMATION BASE

The safety program information base assembled for use in the alignment analysis consisted of three elements

a. FAA programs active during the 1964 to 1976 time period that were primarily safety oriented

b. An accident preventor list consisting of facilities and equipment that might have precluded accidents had they been present

c. A compendium of safety recommendations made by the NTSB and contained in its safety recommendations data base (SAREC)

The respective elements of this information base are described in the following paragraphs.

FAA Safety Programs

A list of 90 safety programs active during the 1964 to 1976 time period was compiled based on information in several FAA source documents. These sources included fiscal year reviews of FAA activities, national aviation system plans, engineering and development program plans, safety related engineering and development activities and program overview and highlight reports. Drawing on statements of objectives and related descriptive information, a program was included in the safety program list if:

a. Its primary objective was safety related

b. The program was listed under a safety related category in its reference document

c. The program represented an effort to improve safety in an existing operational program

d. The primary objective of the program served some other purpose (e.g., increase in capacity), but also contained elements which contributed significantly to safety.

Original Accident Cause/Factor Citations		Equivalent Modified Cause/Factor Citations	
Causes	Associated Cost	Cause	Associated Cost
70ACJ	$73,454.54	70ACJ	$101,000.00
88A38	"	Deleted	--
88A33	"	Deleted	--
75AAY	"	75AAY	101,000.00
68AJ0	"	68AJ0	101,000.00
64A19	"	64A02	202,000.00
64A44	"	64A03	101,000.00
64A31	73,454.54		

Factors	Associated Cost	Factors	Associated Cost
88J05	$18,363.68	Deleted	--

THE TOTAL ORIGINAL ACCIDENT CAUSE/FACTOR CITATIONS		THE TOTAL MODIFIED ACCIDENT CAUSE/FACTOR CITATIONS	
Causes	Factors	Causes	Factors
8	1	5	0

$606,000.00 THE TOTAL COST REMAINS THE SAME FOR THE ACCIDENT $606,000.00

FIGURE 2-4. DISTRIBUTION OF ACCIDENT COST AMONG CITED CAUSES AND FACTORS AS ENCODED ACCORDING TO THE MCC AND THE MODIFIED FRAMEWORK

An initial listing of 104 programs was compiled. This listing was subsequently compressed to 90 programs through merging of several partially redundant program elements.

For purposes of the alignment analysis, these programs have been classified into six functional categories as follows:

a. Facilities and Equipment
b. Safety Research and Development
c. Operations Safety
d. Regulatory Programs
e. Capacity Programs with Safety Contributions
f. Management and Administrative Programs with Safety Contributions.

The programs within each of the above categories are listed in Tables 2-10 through 2-15, respectively. These program listings were circulated to various FAA offices for review with respect to completeness and accuracy.

Accident Preventor List

Table 2-16 consists of a list of facilities identified by the FAA as "possible accident preventors." An accident preventor is defined as a facility, which had it been present at the time and location of an accident, might have precluded the occurrence of that accident. As part of the detailed accident records examination, a conservative judgment was made with respect to accident prevention possibility given the presence of a facility on the preventor list. These judgments were based on review of the specific circumstances surrounding each accident.

NTSB Safety Recommedations (SAREC)

In executing its safety responsibilities, the NTSB makes safety recommendations that are based on the results of investigations of one or more similar types of aircraft accidents. These investigations or studies can result in highly specific recommendations such as a mechanical fix for a particular aircraft make and model (e.g., an airworthiness directive) or more general recommendation calling attention to a significant system hazard. These recommendations are transmitted to the FAA for its evaluation and action, where appropriate.

TABLE 2-10. FAA SAFETY PROGRAMS:
FACILITY AND EQUIPMENT*

Code	Program Description
101	ATCT- CS/T - Air Traffic Control Tower - Combined Station/Tower (1964)
102	Automation of Flight Assistance and Weather Information Service (1975)
103	Automation of Preflight Briefing Services (1977)
104	D. F. Equipment Improvements (1964)
105	Equip Remaining VOR's with DME (1973)
106	Add DME to ILS (1972)
107	REIL - Runway End Identification Lights (1964)
108	VASI - Visual Approach Slope Indicator (1964)
109	LDIN - Lead in Lighting System (1965)
110	Frangible Approach Light Mounting Retrofit (1975)
111	OMNI - Directional REIL/RAIL (Runway Alignment Indicator Lights) (1976)
112	BRITE - (Bright Radar Indicator Tower Equipment) (1967)
113	ARTS II (1972)
114	ASR - 8 (1964)
115	Revised Approach Lighting System (MALS, MALSR, SSALS) (1967)
116	Simplex Radar Digitizer Replacement Program (1978)
117	Runway Grooving Program (1972)
118	EARTS/DARC - Enroute Automated Radar Tracking System/Discrete Access Radar Channel (1979)

* The year the program started is given at the end of each program description.

TABLE 2-11. FAA SAFETY PROGRAMS: SAFETY RESEARCH AND DEVELOPMENT*

Code	Program Description
201	Radar Tracking of Nonbeacon Equipped A/C - ARTS III (1970)
202	Conflict Alert - ARTS III - (Software) (1975)
203	Weather Radar Display System (ASR - 57)
204	ATARS - Automatic Traffic Advisory and Resolution Service (1974)
205	Instrument Landing Approach Aids (1961)
206	BCAS/APWI - Collision Avoidance System/Proximity Warning Indicator (1975)
207	Fog Dispersal Research (1970)
208	New Equipment Development for Crash and Fire Rescue (1960 continuous)
209	Snow/Ice/Slush Removal Methods (1964)
210	Hazardous Materials Transport and Handling System Investigations
211	Fire Safety Research - Inflight/Post Crash/Ground (1964)
212	New Bomb and Weapon Detection Systems (1976)
213	Crashworthiness Programs - Air Carriers/GA (1972)
214	MLS - Microwave Landing System (1971)
215	ASTC-ASDE-Airport Surface Traffic Control - Airport Surface Detection Equipment (1966)
216	WVAS - Wake Vortex Avoidance System (1970)
217	DABS - Discrete Address Beacon System (1972)
218	Cockpit Human Factors Research (Hardware) (1977)
219	Wind Shear Program (1972)
220	All Weather Landing System (1961 Approx.)
221	Pilot Training Research Program (1965)
222	Experiments on Preventing Disorientation (Date Unknown)
223	Biomedical Experiments on Visual Collision Avoidance (Date Unknown)
224	Studies on Controller Stress (Date Unknown)
225	AV-AWOS - Automatic Weather Observation System (1973)

* The year the program started is given at the end of each program description.

TABLE 2-12. FAA SAFETY PROGRAMS: OPERATIONS SAFETY*

Code	Program Description
301	Increased Emphasis on Detecting/Sensing/Tracking Hazardous Weather (1977)
302	Organization and Participation in Clinics/Meetings/Group Discussions to Increase Pilot and Crew Member Knowledge/Techniques/Skills and Safety Awareness (1968)
303	Airport Security Programs (1970-Skymarshalls and 1972 Airports)
304	Screening of Surplus Military Aircraft Prior to Dispersal (1973)
305	QASAR - Quality Assurance Systems Analysis Review (1971)
306	Hazardous Material Inspections (1974)
307	New Cabin Safety Rules (1961)
308	MAC - Maintenance Analysis Center (MRRS/MISRS/MDRS) (1963)
309	MSAW (ARTS III Improvement) Minimum Safe Altitude Warning System (1976)
310	SWAP - Systemworthiness Analysis Program (1966)
311	Review and Revision of Pilot/Controller Glossary (1977)
312	TAP - Technical Appraisal Program for ATC (1976)

* The year the program started is given at the end of each program description.

TABLE 2-13. FAA SAFETY PROGRAMS: REGULATORY PROGRAMS (FAR's)*

Code		Program Description
401	FAR Part 13	Enforcement Procedures (11/1962)
402	FAR Part 21	Certification Procedures Product and Parts (2/1965)
403	FAR Part 23	Air Worthiness Standards - Normal, Utility, Acrobatic Airplanes (1/1965)
404	FAR Part 25	Air Worthiness Standards - Transport Category Airplanes (2/1965)
405	FAR Part 27	Air Worthiness Standards - Normal Certified Rotorcraft (2/1965)
406	FAR Part 29	Air Worthiness Standards - Transport Category Aircraft (2/1965)
407	FAR Part 33	Air Worthiness Standards - Aircraft Engines (2/1965)
408	FAR Part 35	Air Worthiness Standards - Propellers (2/1965)
409	FAR Part 37	Technical Standard Order Authorization (1/1965)
410	FAR Part 39	Air Worthiness Standards - Procedures (11/1964)
411	FAR Part 43	Maintenance, Preventive Maintenance, Rebuilding Alterations (7/1964)
412	FAR Part 61	Certification: Pilot and Flight Instructors (11/1962)
413	FAR Part 63	Certification: Crew Members (Other than above) (11/1962)
414	FAR Part 65	Certification: Airmen (Other Than 61 and 63) (11/1962)
415	FAR Part 67	Medical Standards and Certification (11/1962)
416	FAR Part 91	General Operating and Flight Rules (9/1963)
417	FAR Part 93	Air Traffic Rules and Airport Traffic Patterns (9/1963)
418	FAR Part 107	Airport Security (3/1972)
419	FAR Part 121	Certification and Operation: Air Carrier and Commercial Operators Using Large Airplanes (4/1965)
420	FAR Part 123	Certification and Operation: Air Travel and Clubs (10/1968)
421	FAR Part 135	Air-Taxi and Commercial Operators of Small Aircraft (9/1964)
422	FAR Part 139	Certification and Operation: Land Airports Serving Air Carriers (Other Than Helicopters) (7/1972)

* Date of implementation is given at the end of each program description, but it is noted that most FAR's have undergone general revisions since implementation.

TABLE 2-14. FAA SAFETY PROGRAMS: CAPACITY PROGRAMS WITH SAFETY CONTRIBUTIONS

Code	Program Description
501	National ATCSCC - To Enhance Safety and Efficient Operation of Aircraft Throughout 20 ARTCC System
502	Airways Facilities System Checking
503	Full ILS Program Installation
504	Establish Localizer/Marker/Approach Lights at Airports Not Qualifying for Full ILS
505	Establish TVOR's at Qualifying Airports
506	Area Navigation System (RNAV)
507	Aircraft Separation/Navigation Standards Program

TABLE 2-15. FAA SAFETY PROGRAMS: MANAGEMENT AND ADMINISTRATIVE PROGRAMS WITH SAFETY CONTRIBUTIONS

Code	Program Description
601	Biennial Review of Airworthiness and Operations Regulations
602	Increasing the Effectiveness of Delegation Option Authorization (DOA) Program
603	Examining the Use of a Random Sampling Program for Management and Enforcement for General Aviation
604	Automation of the Process of Developing New Instrument Flight Procedures
605	Review of TCA Establishment Requirements
606	Review of TRSA Establishment Requirements
607	Advisory Information Services Regarding Compliance and Standards for ADAP, Part 139 and Part 121

TABLE 2-16. FAA FACILITIES LIST FOR ASSIGNMENT AS POSSIBLE ACCIDENT PREVENTORS

Assignment Code	Facility or Resource
	Enroute
801	Long-Range Radar
802	VORTAC
803	Communication
804	DF
805	Weather Facilities
806	ATC
	Terminal
807	ILS-CAT I, II, III ALS/MALS
808	VASI
809	REIL
810	ASR
811	ASDE
812	Weather Facilities
813	Communication Facilities
814	ATCT
815	TVOR
816	Localizer
817	DME
818	WVAS
819	Wind Shear Detection
820	TCA
821	ARTS III

These NTSB recommendations, documented in a computerized information system (SAREC), were included in the safety program information base for the purpose of possible alignment of programs not directly aligned with the cause/factors in the modified framework. That is, FAA safety programs that were otherwise unaligned were reconsidered with respect to potentially applicable SAREC recommendations.

The safety recommendations generally fall in one of the following five categories:

a. Airworthiness Directives, Alert and Compliance Bulletins

b. Testing and Research Requests

c. Cabin Safety

d. Review of Procedures, Regulations, and Standards

e. Miscellaneous.

Cabin safety recommendations usually are subsumed in one of the other categories. However, because of the high number of such recommendations in the SAREC file, and because of their relation to certain safety programs, they were separately identified. The last category, miscellaneous, consists mainly of equipment installation requests at various facilities.

ANALYSIS AND EVALUATION METHODOLOGY

The cause/factor and safety program analysis and evaluation methodology consists of three parts:

a. Accident cause/factor frequency and associated cost analysis

b. Cause/factor and safety program alignment analysis

c. Safety program effectiveness evaluation

The respective methods used for the above cited analyses and evaluation are described in the following Sections.

Accident Cause/Factor Analysis

The purpose of the analysis of the air carrier accident cause/factor data is twofold: to document the relative severity of accident cause/factors, and

to identify the levels of cause/factor aggregation that are appropriate for safety program alignment. With respect to the first purpose, the relative severity of accident cause/factors, descriptive statistics are tabulated that portray

a. Rank ordered individual cause/factor frequency counts for the 13 year period

b. Rank ordered accident costs associated with individual cause/factors for the 13 year time period

c. Cause/factor frequency counts and associated costs by year.

d. Total and annual number of deaths, major injuries and minor injuries by associated cause/factor

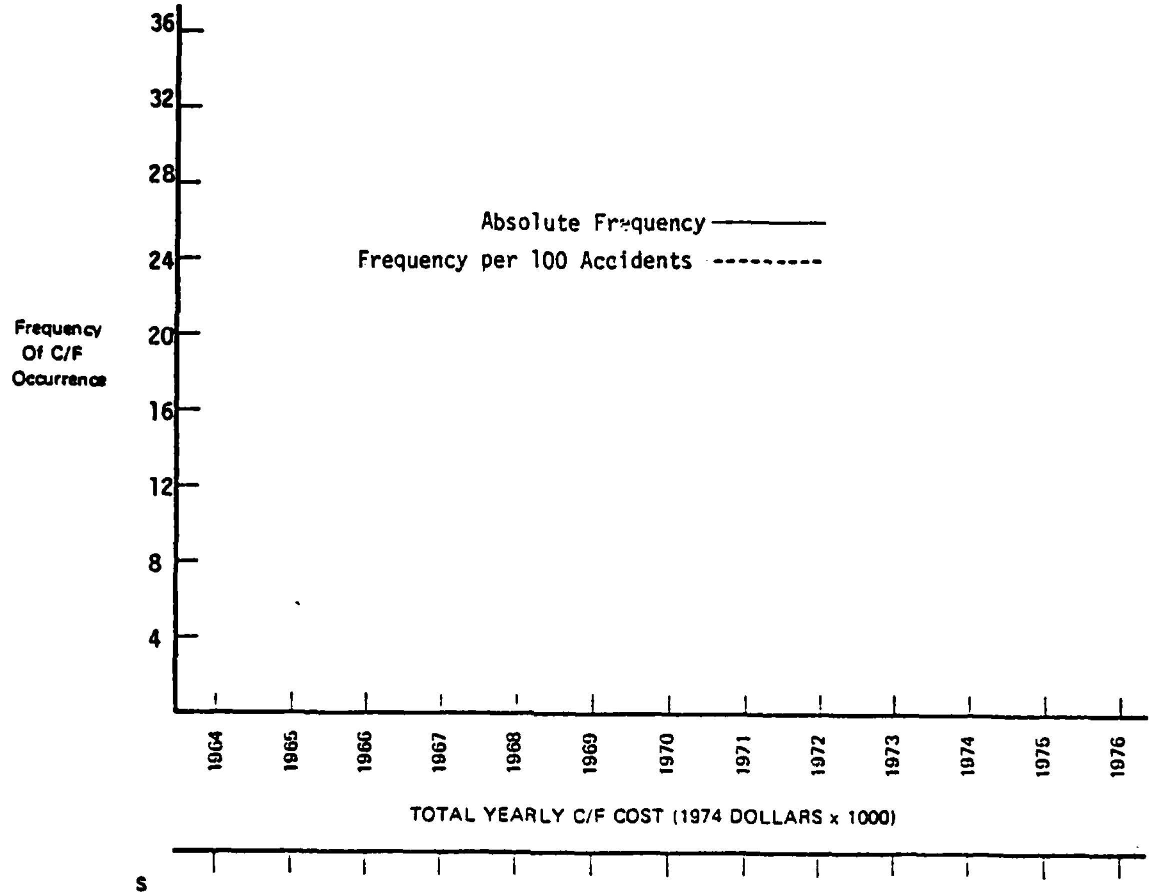
e. Cause/factor frequency counts by type of accident.

Further, these statistical tabulations are summarized in time series plots for each of the 13 major cause/factor categories listed in Table 2-4. The time series data are plotted in terms of both absolute and relative frequencies. Number of cause/factor citations per 100 accidents is used as the relative frequency measure. This normalized measure was chosen because it portrays cause/factor severity with respect to the population of interest in this study (air carrier accidents, as opposed, for example, to aircraft operations or aircraft hours). The format used for these summary time series plots is shown in Figure 2-5.

Cause/Factor Aggregation. Relatively few cause/factors are cited by accident investigators with sufficient frequency to permit detection of statistically significant changes in their rates of occurrence. The majority of cause/factors listed in the MCC and in the modified framework are cited at a rate of less than once a year, if at all. Accordingly, these rarely occuring cause/factors have been aggregated within major cause/factor categories to provide partial, lower resolution data to be used in detecting trends that might be attributable to safety program effects.

The procedure used for cause/factor aggregation is as follows:

a. An individual cause/factor cited at a rate of no greater than once every two years, and not cited more than twice in the 1975 and 1976, was listed for aggregation.



(Costs are in 1974 Dollars (000)

TOTAL ASSOCIATED FATALITIES . . . . From FAADAS Data

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . From FAADAS Data
TOTAL ACCIDENTS . . . .

TOTAL ASSOCIATED COST AS CAUSE . . . . .
TOTAL ASSOCIATED COST AS FACTOR . . . . . From FAADAS Data
TOTAL ASSOCIATED COST. . . . .

FIGURE 2-5. MAJOR CAUSE/FACTOR CATEGORY SUMMARY: FREQUENCY AND COST (Category Identification)

b. These individual cause/factors were then aggregated under their respective major cause/factor category codes.

For example, if cause/factor 76*AA (Flight Altimeter) was cited, say four times in 13 years as a cause of an accident (and not in 1975 or 1976), its frequency of occurrence and associated costs were transferred to the collecting code, 76*00 (Instruments/Equipment). This process was repeated for all code 76*XX cause/factors that met the aggregation test. Thus, the summation in code 76*00 represents all apparently random occurrences of the individual cause/factors in the major cause/factor category. This same process was repeated for all major cause/factor categories.

This accumulation of apparently random events into intermediate cause/factor categories is of particular value in the case of mechanical cause/factors, where individual cause/factors are often at too low a level of disaggregation to align with a safety program. For example, the cause/factor Code 74*SK denotes not only a powerplant failure, but a failure of the fuel system, and more specifically, the malfunctioning of the fuel system's pressurizing and dump valve. While this information is vital for an engineer to determine why the engine fire occurred, for purposes of creating a more general program for, say, maintenance procedures or post crash fire safety, it is sufficient to know that a fuel system or powerplant failure occurred. Thus, because alternative safety programs are aimed at different levels of a system hazard, this conversion of "rare events" to a higher level of aggregation facilitated their use in evaluating corresponding safety programs.

Cause/Factor and Safety Program Alignment Analysis

The alignment analysis addresses two questions. First, are there one or more safety programs directed toward mitigating hazards implied by the citation of significant cause/factors? Second, are there safety programs directed toward mitigating hazards that do not appear to be empirically significant because of infrequent cause/factor citations? In short, this analysis concerns the completeness of the mapping between programs and significant cause/factors.

The primary component of the alignment analysis consists of comparing cause/factor descriptions against the objectives of the 90 FAA safety programs listed in Tables 2-10 through 2-15. Secondly, nonaligned safety programs

are related, where possible, to NTSB safety recommendations contained in the SAREC file. Finally, accidents are related to facilities identified in the accident preventor list given in Table 2-16. Specifically, this procedure consists of the following sequence:

a. High frequency individual or aggregated cause/factors are determined to be aligned with safety programs where there exists a direct or indirect correspondence between the cause/factor definition and the safety program objective. This step yields three results: aligned cause/factors and safety programs, unaligned cause/factors, and unaligned safety programs.

b. Those safety programs not aligned with the empirical cause/factor citations in the accident data base are then tested for alignment with cause/factors in the MCC, but not used by accident investigators over the 13 year study period. The alignment criteria and result categories are the same as in the first step.

c. Those cause/factors not aligned with safety programs in the first analysis step are reviewed in the context of the potential hazards they represent. Associated hazards judged to be potentially significant in the present aviation environment are subsequently considered in the safety program effectiveness evaluation.

d. Similarly to unaligned cause/factors, safety programs unaligned with cause/factors or NTSB safety recommendations are reconsidered in the effectiveness evaluation.

Cause/Factor and Safety Program Alignment Criteria. The criteria used in aligning safety programs and cause/factors are qualitative indicators of the congruence between program objectives and hazards implied in the cause/factor definitions. Specifically, alignments are determined to be direct, indirect, or nonexistent in accord with the following definitions:

a. Direct Alignment. The mitigation of the hazard implied in the cause/factor definition is stated as a specific objective of the aligned safety program. That is, there exists one-to-one congruency between hazard and objective.

b. Indirect Alignment. The mitigation of the hazard implied in the cause/factor definition may be partially stated or subsumed in the objective of a safety program.

That is, there exists a partial congruency between hazard and objective. For example, FAR Part 29, Air Worthiness Standards-Transport Category Aircraft (program code 406) includes standards for landing gears (major subdivision cause/factor code 70) which subsume several individual cause/factors such as main shock assembly structures (code 70*CA), nosewheel assembly (code 70*CE), etc.

c. No Alignment. Safety programs and/or cause/factors that fail the above defined congruency criteria are determined to be nonaligned. Nonaligned safety programs should not necessarily be construed as being unwarranted, nor should nonaligned cause/factors be construed as being unattended hazards. The interpretation of such nonalignments is dealt with the in-safety program effectiveness evaluation.

Safety Program Evaluation

The purpose of the evaluation is to determine the extent to which the FAA safety programs mitigate air carrier accident causes, and, based on these findings and the attributes of the overall safety program structure, to make recommendations for program improvements. The criteria and methods used in this evaluation are described in the following paragraphs.

Evaluation Criteria. The effectiveness of FAA's safety programs is evaluated in this study in accord with three principal considerations:

a. Changes in frequencies of cause/factor citations of the 13 year study period that can be attributed to safety program impacts.

b. The effectiveness of the means by which programs addressed safety problems at various cause/factor hierarchial levels.

c. The extent to which related safety programs contributed to overall aviation system safety, especially within major cause/factor categories.

The first consideration is a direct measure of empirical improvements in aviation safety, and is based on the descriptive statistics and alignment results. The latter two considerations pertain mainly to how effectively single and multiple, related programs are designed and implemented.

Safety Program Cost Evaluation. Although it had been planned to conduct a detailed evaluation of the program costs, safety program financial data were not examined in this study. Cost evaluations were not made for two reasons. First, proper cost evaluation would require development of a complex methodology for allocating cumulative costs of combinations of programs among aligned cause/factors at different levels of aggregation. That is, because interdependent safety programs are implemented at different levels in the cause/factor hierarchy, attempts to directly associate costs with singular safety program-cause/factor alignments would likely lead to inaccurate conclusions. The development of such a methodology was considered to be beyond the scope of this study. Second, comprehensive program cost data assembled in the format required to implement such a methodology could not be provided in the course of this study.

Evaluation Procedures. The FAA safety programs listed in Tables 2-10 through 2-15 were evaluated in three steps with respect to the considerations described in the above section, "Evaluation Criteria"

a. Association of cause/factor frequency changes with corresponding implementation timing of aligned safety programs

b. Use of an accident cause fault tree for assessing safety program interdependencies and their respective points of implementation in the accident cause hierarchy

c. Classification of safety programs in terms of the types of action taken toward improving systems safety performance

These procedures are separately described in the following paragraphs.

Cause/Factor and Safety Program Associations. Apart from other influencing variables, an effective safety program should be empirically demonstrable through observation of a decreasing citation rate or downward shift in level of cause/factor(s)corresponding to the implementation of the aligned program(s). This evaluation step is directed toward identifying such empirical associations based on the cause/factor citation frequency histories (given in the descriptive statistics part of the cause/factor data analysis) and on the safety program implementation dates (given in the safety program data base section of this report).

In seeking these associations, it is apparent a priori that several factors exist that tend to mask such empirical cause-effect relationships. First, most individual cause/factor frequency rates are too low to detect statistically significant changes (the rare event problem). As discussed earlier, cause/factors have been aggregated at higher levels to partially offset this problem. Second, many safety programs are indirectly aligned with cause/factors. This is generally true of monitoring, regulatory and educational programs and, also, generally characteristic of programs aligned at higher levels in the accident cause hierarchies. Third, changes over time in the aviation environment alter relative exposure rates to aviation hazards which, of course, also influence cause/factor frequency rates. These factors are dealt with qualitatively to the extent practicable in this step of the evaluation procedure. The subsequent evaluation steps are designed in the main to provide further insights on program effectiveness that are not masked by the above factors.

The Accident Cause Fault Tree. A fault tree is a conceptual model used for calculating the probabilities of particular events given a set of causal circumstances and logical relationships among these circumstances. This method is widely used in systems safety investigations (for example, nuclear power plants and automated control systems). In simple terms, a fault tree consists of event chains leading to system failure and are specified in terms of hierarchial "and/or" relationships between all possible factors affecting system performance.

Three interconnected fault trees have been developed in this study for safety program evaluation. These fault trees portray, respectively

a. Human error accident causes (Figure 2-6)

b. Mechanical accident causes (Figure 2-7)

c. Environmental accident causes (Figure 2-8)

The logic symbols used in these fault trees are defined in Figure 2-9.* For their intended use in this study, these fault trees are strictly qualitative. That is, they portray the logical structure of accident cause-event chains,

* Handbook of System and Product Safety by W. Hammer, Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632, (1972).

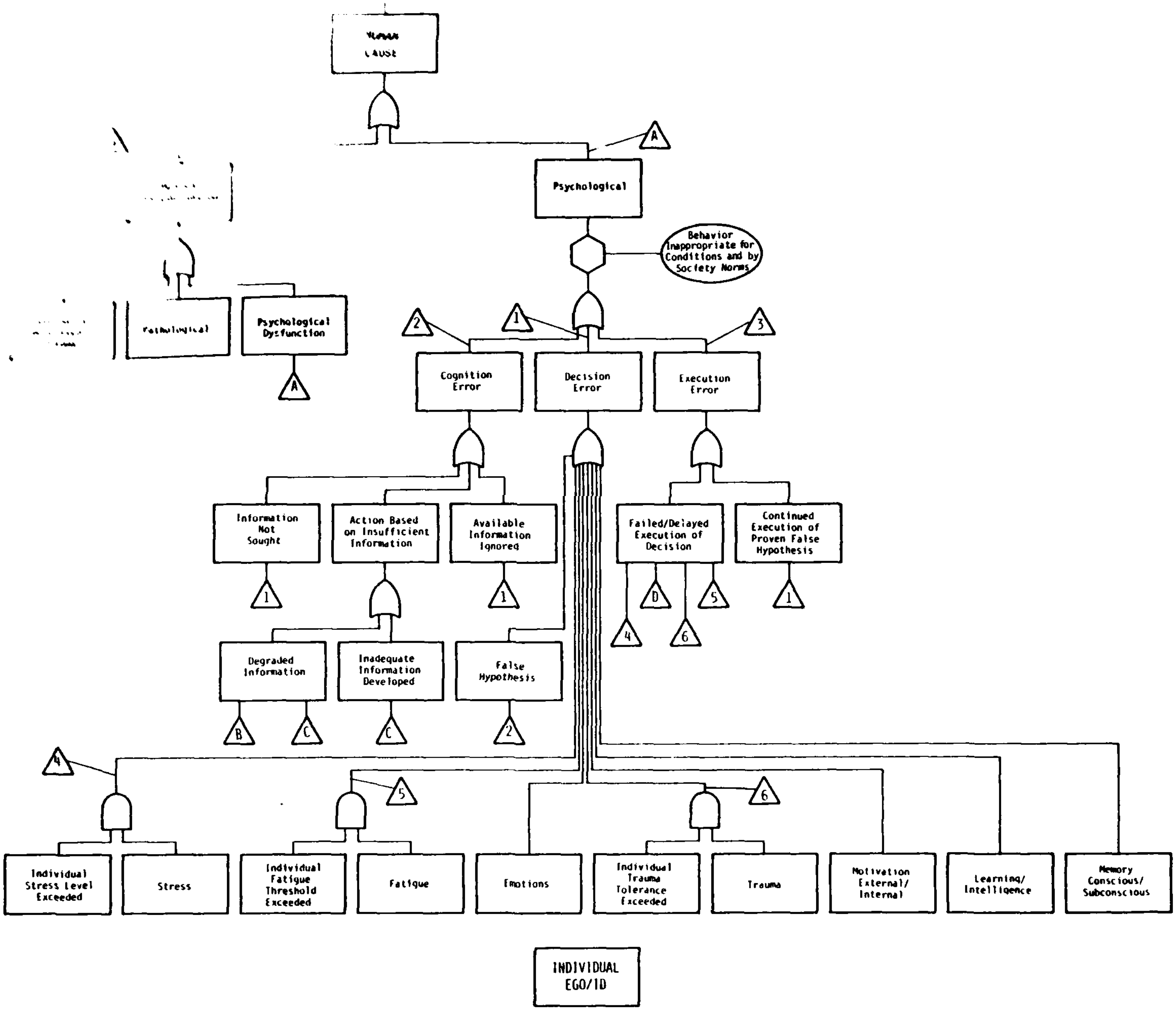


FIGURE 2-6. HUMAN CAUSE FAULT TREE

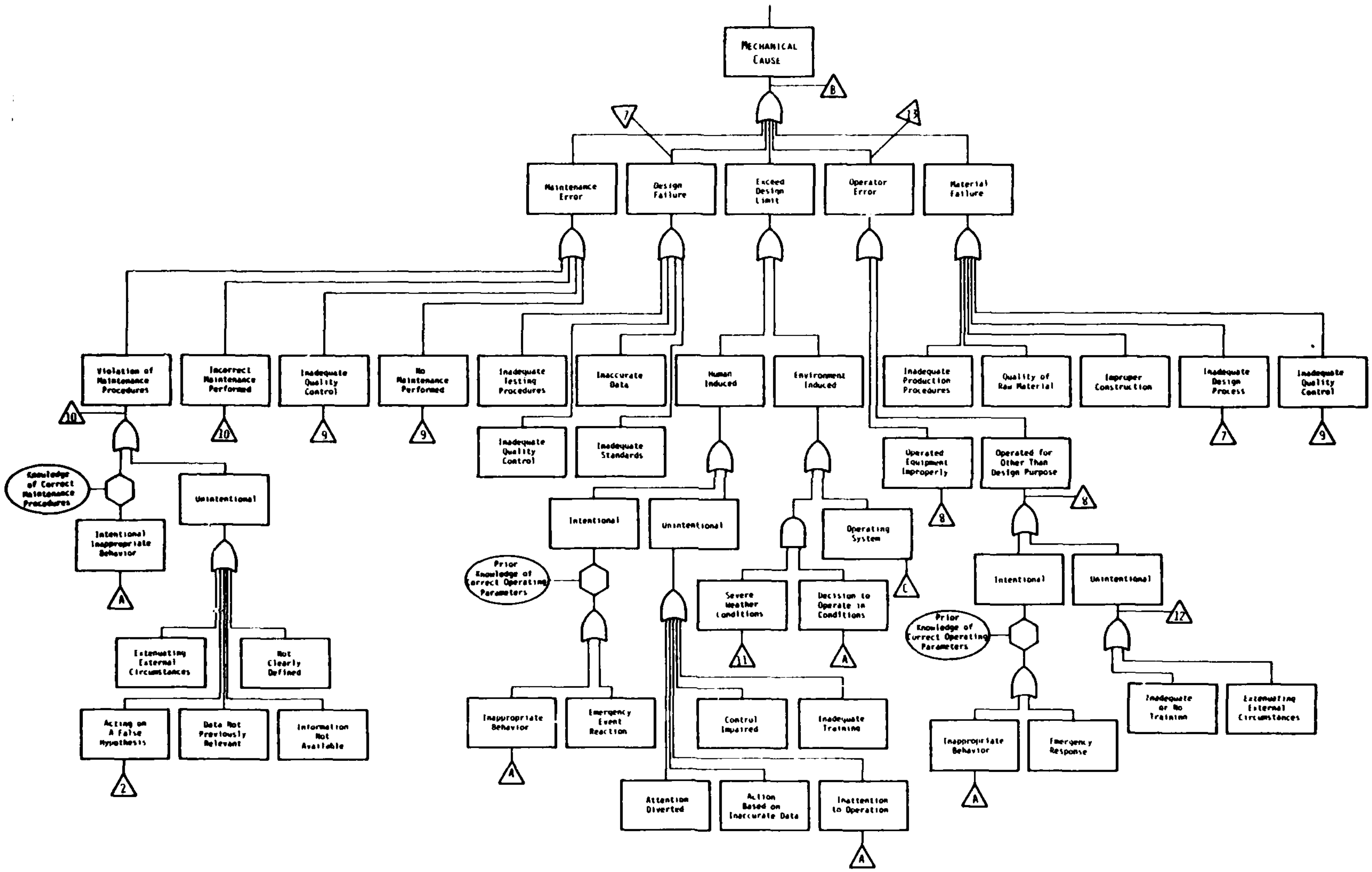


FIGURE 2-7. MECHANICAL ERROR FAULT TREE

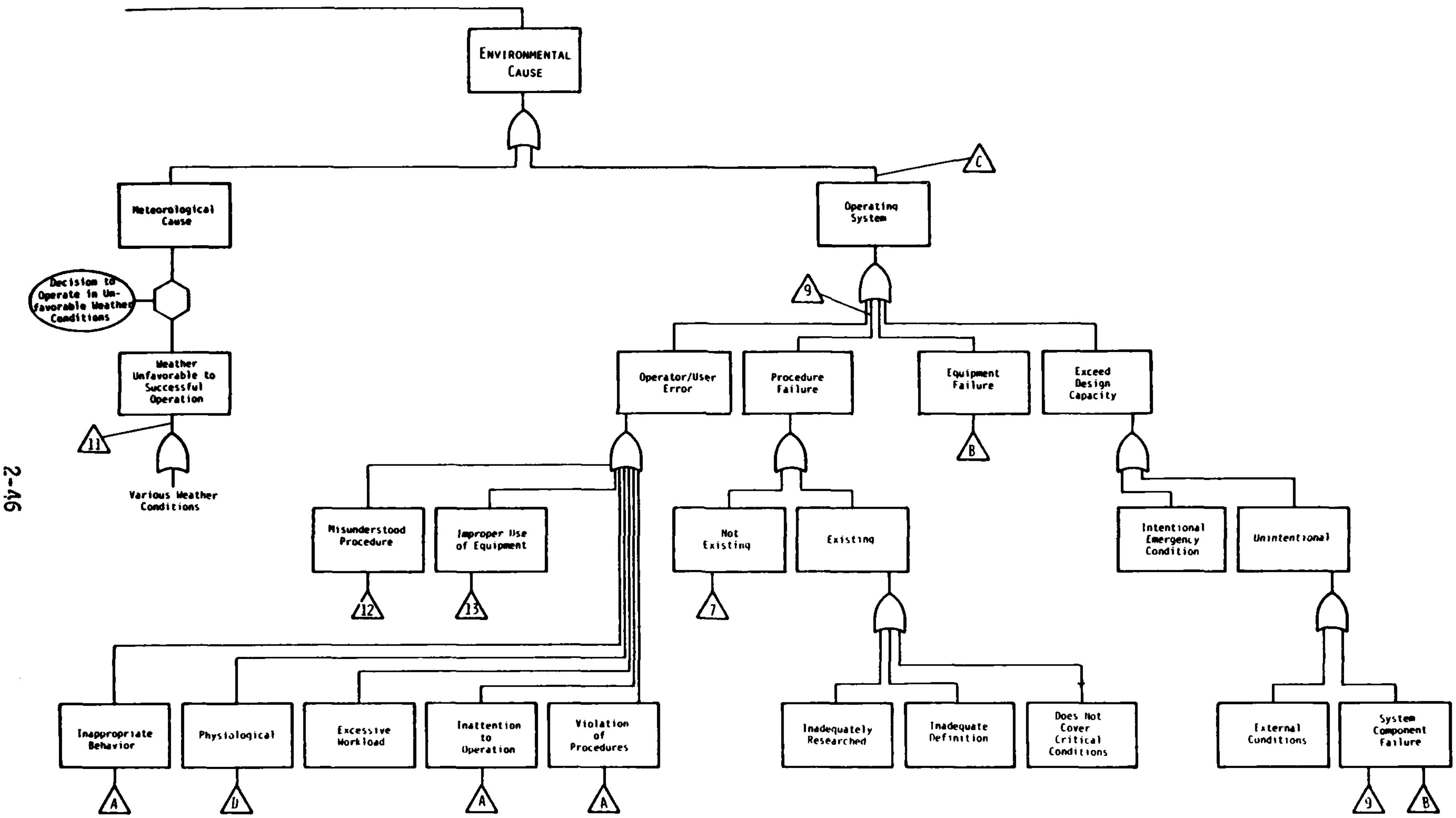
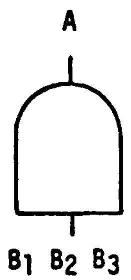
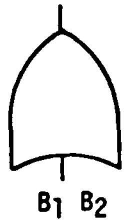


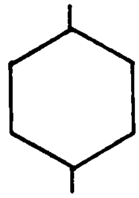
FIGURE 2-8. ENVIRONMENTAL CAUSE FAULT TREE



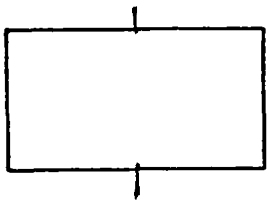
AND Gate. An AND gate is used to denote an event that can only occur if all of the input events also occur. For example, Output A cannot occur unless inputs B_1, B_2 and B_3 occur.



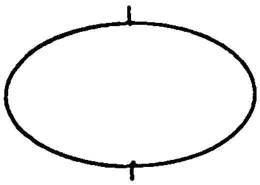
OR Gate. An OR gate is used to denote an event that can occur if any one (or combinations thereof) input event occurs. For example, event A can occur if either or both B_1 or B_2 occurs.



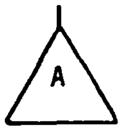
INHIBIT Gate. An INHIBIT gate permits applying a condition or restriction to the sequence that must be satisfied for an output to be generated.



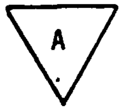
EVENT IDENTIFICATION. Usually describes the output or input of an AND or an Or gate.



RESTRICTION IDENTIFICATION Usually indicates a restriction or stipulation when used with an INHIBIT gate.



INPUT SYMBOL A connecting symbol to another part of the fault tree within the same or another major branch and has a matching OUTPUT symbol.



OUTPUT SYMBOL A connecting symbol to another part of the fault tree to show continuation of the error path(s).

FIGURE 2-9. FAULT TREE SYMBOLS

but no attempt has been made to estimate event probabilities.

The use of these fault trees is predicated on conditions present in all aircraft accidents: a precipitating (or first) cause, and the logic relationships through which this first cause may result in an accident or incident. Given a clear picture of an accident's cause-effect chain, it is possible to determine at what levels in the chain remedial safety actions can be taken and what their potential effectiveness might be. The fault tree is used here to provide such an assessment of existing programs in terms of the hierarchy of alignments between interdependent programs and aligned accident cause/ factors. The results of this fault tree application provide an overall systems safety basis for making recommendations that address gaps in existing safety program coverage.

It should be noted that fault trees presented in this report are not highly detailed. Fault trees that traced all the cause-event chains to their lowest logical level would add several hierarchial levels. They would eventually lead to a common cause: human error. Such detailed information is clearly impractical as a working tool given the boundaries of factual (observable) data recoverable from accident investigations. Further, factual data necessary to corroborate alternative human behavior concepts is limited and subject to controversy among experts. Thus, the fault trees used here stop short of attempting to capture basic human behavior. Rather, these fault trees deal with observable facts about accidents and present the possibilities for their cause. Based on such findings, directions for further reasearch are recommended.

Classification of Safety Programs by Type of Activity. FAA safety programs examined in this study are classified into four categories as follows:

a. Programs that are directed at assisting system operators (pilots, air traffic controllers, etc.) in the performance of their work. These programs can have the dual purpose of increasing system capacity while enhancing safety (e.g., ILS, VASI, DME, ARTS III, etc.)

b. Programs which form an active monitoring system of checks and balances on the aviation industry's equipment, manufacturing, maintenance, and operational procedures (i.e., SWAP, MAC, QASAR, etc.). Also classified within this category are other operational phase monitoring systems such as

conflict prediction, MSAW, detection/tracking of hazardous weather and the tracking of non-beacon equipped aircraft (an ARTS III improvement)

c. Programs which are remedial in nature and are designed to counter new or increasingly troublesome safety threats in the system (i.e., wind shear detection, crashworthiness, hazardous material handling, frangible approach light systems, etc.)

d. Regulations, procedures, education and enforcement programs directed at maintaining an overall minimum safety level in the aviation system (i.e., FAR's, safety seminars, spot checks, cabin safety, etc.).

This classification of safety programs in conjunction with the fault tree evaluations previously described provided another means of determining safety program effectiveness based on the "approach" to the safety problem they address. Thus, for example, even though different safety programs might have the same objective, their effectiveness (or lack thereof) might depend on their approach.

CHAPTER 3.0. SAFETY PROGRAM ANALYSIS AND EVALUATION

In this chapter, analyses and evaluations of FAA safety programs with respect to the causes of air carrier accidents for the time period from 1964 through 1976 are described. Using the data base and methodology described in the preceding chapter, these analyses and evaluations are presented in three parts

a. Air carrier accident cause/factor analysis
b. Safety Program and cause/factor alignment analysis
c. Safety program evaluations.

These topics are treated in the following sections of this chapter in the order cited above.

AIR CARRIER ACCIDENT CAUSE/FACTOR ANALYSIS

The results of this analysis consist of documentation of the relative severity of accident cause/factors, and determination of the levels of cause/factors aggregation/disaggregation best suited to the safety program alignment analysis. These results are presented in terms of descriptive statistics portraying cause/factor frequency, accident deaths and injury, and associated costs.

Overview of Air Carrier Accidents

Over the 1964 through 1976 time period, there were 800 air carrier accidents involving 824 aircraft. The frequency distribution of these accidents for this 13 year period is shown in Figure 3-1. It is seen from this figure that the number of accidents per year declined significantly between 1964 and 1971, remained fairly constant through 1974, and again declined in 1975 and 1976. The highest number of accidents (86) occurred in 1965 and the lowest number of accidents (30) occurred in 1976. Adjusting these absolute annual frequencies to an annual rate, expressed in terms of the number of accidents per ten million operations, shows a more precipitous decline in the mid-1960's; but no significant deviation from the corresponding absolute frequencies thereafter. In these terms, it is seen from Figure 3-1 that accidents per ten million operations was at its highest (112) in 1964, and at its lowest (33) in 1976.

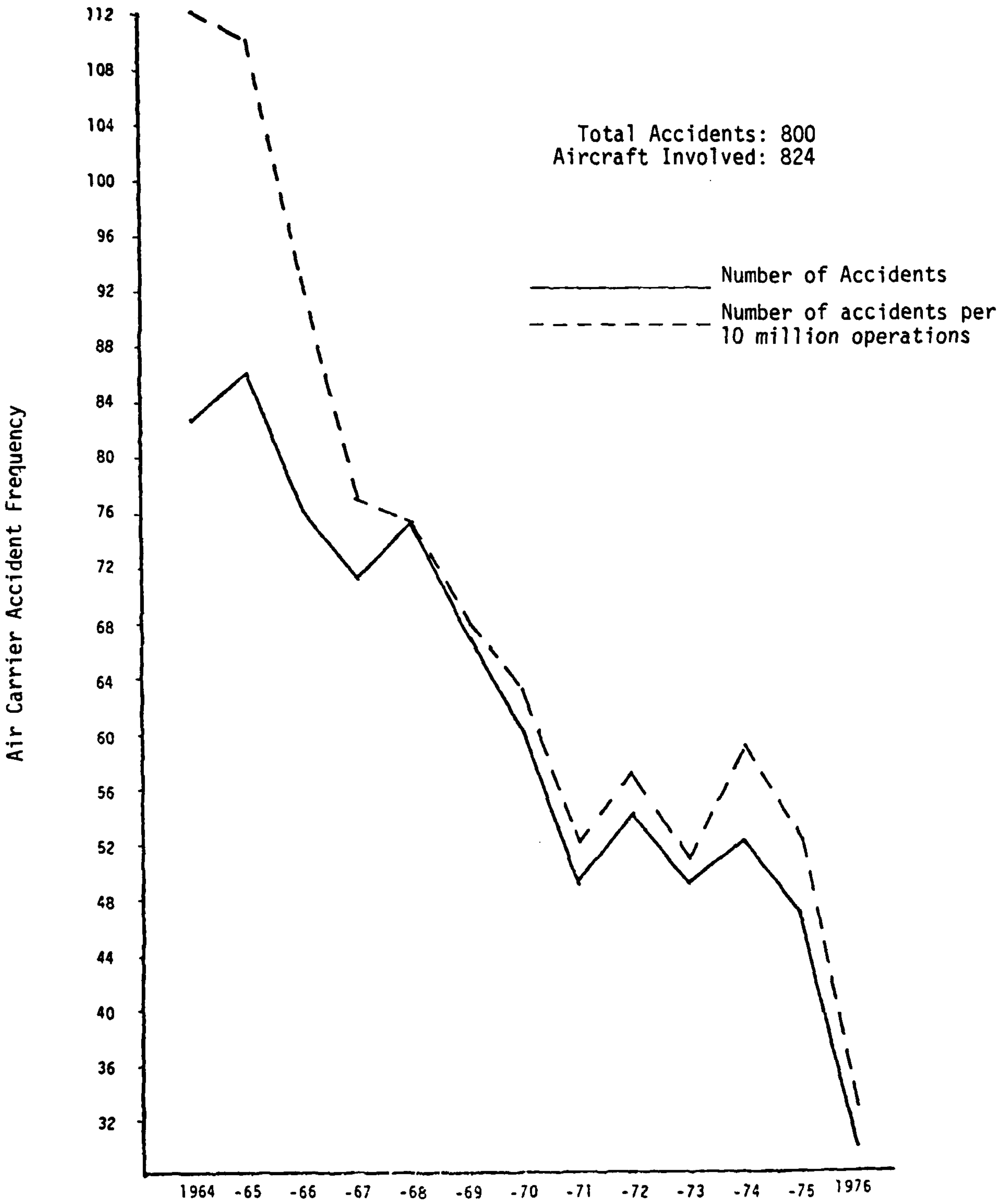


FIGURE 3-1. AIR CARRIER ACCIDENT HISTORY
(January, 1964 through December, 1976)

The number of deaths and injuries, and dollar loss associated with these 800 accidents are summarized in Table 3-1. The dollar loss amounts are based on the cost methodology described in the preceding chapter. Specifically, deaths, major injuries and minor injuries are valued at $300,000, $45,000 and $6,000, respectively. Aircraft loss is valued at replacement cost at the time of the accident, and substantial damage is valued at one-third of replacement cost. All costs are given in 1974 dollars based on the implicit price deflator values given in Table 3-2.

TABLE 3-1. ACCIDENT DEATHS, INJURIES AND DOLLAR LOSS

Total Air Carrier Accidents	800
Total Aircraft Involved	824
Total Deaths	3,412
Total Serious Injuries	1,135
Total Minor Injuries	1,767
Total Dollar Loss	913,217,000[(a)]
Cause/Factor Assigned	836,278,000 (94%)
Cause/Factor Unassigned	54,939,000 (6%)

(a) Includes $22,000,000 estimated aircraft replacement value for years 1964-1965 not originally provided by the FAA data.

Table 3-3 summarizes accident cause/factor frequency citations based on both the existing NTSB cause/factor code listing given in the MCC and the modified cause/factor code listing developed for purposes of the safety program alignment analysis. With respect to the MCC codes, it is seen from this table that approximately 50 percent of the possible cause/factor codes were cited as cause or factor in the 800 accident records. Approximately 25 percent were cited as cause. Of the 326 codes cited as cause only 68 (less than 10 percent of the total possible codes) were cited at a rate of at least once in two years. Using the modified cause/factor framework, approximately 37 percent of the possible codes were cited as cause or factor; 19 percent were cited as cause only; and, of the total of 176 such codes, only 40 codes (23 percent) were cited at a rate of once in two years. These statistics clearly depict the "rare event" problem described

TABLE 3-2. IMPLICIT PRICE DEFLATION FOR 1974 BASE YEAR

Year	Implicit Price Deflator *
1964	0.62670
1965	0.64058
1966	0.66161
1967	0.68109
1968	0.71169
1969	0.74746
1970	0.78745
1971	0.82762
1972	0.86192
1973	0.91191
1974	1.00000
1975	1.09619
1976	1.15393

* Source: "1978 Economic Report of the President"

TABLE 3-3. SUMMARY OF CAUSE/FACTOR CITATION FREQUENCY

NTSB Cause/Factor Framework (MCC)		MCC Cause/Factor Framework		Modified Cause/Factor Framework
Total Number of Cause/Factors		798		547
Number of Cause/Factors Cited		378		202
Cited as Both Cause and Factor	134		71	
Cited as Cause Only	192		106	
Cited as Factor Only	52		27	
Frequency of Cause Citation		326		176
Cited Less Than 6 Times	258		136	
Cited Less Than 3 Times	190		123	
Cited One Time	133		86	

in the preceding chapter and the consequent need to properly quality inferences concerning the relative severity of accident cause factors.

Cause/Factor Descriptive Statistics

The development of accident cause/factor descriptive statistics entails two steps. The first step consists of identifying those cause/factors occurring with sufficient frequency (either as individual codes in the modified framework or as aggregations of individual codes) to be used in the alignment analysis. The second step consists of generating descriptive statistics for these cause/factors that indicate their relative severity as accident causes.

Cause/Factor Aggregation. The 547 individual cause/factors contained in the modified cause/factor framework were screened and aggregated where required in accord with the methodology described in Chapter 2.0. This screening yielded a set of 49 cause/factor codes as a basis for the analysis and evaluation subsequently described in this chapter. These 49 cause/factors are listed in Table 3-4. Forty of these codes represent individual cause/factors, and nine represent aggregations of low frequency individual cause/factors. The nine aggregated codes are identified in Table 3-5. These codes include any cause/factor cited at a rate less than once in two years, and not cited in 1975 and 1976. (see individual code summaries in Appendix B for the cause/factors aggregated in this manner.)

Cause/Factor Descriptive Statistics. In the following paragraphs, cause/factor descriptive statistics are tabulated and interpreted in terms of their relative severity. Specifically, cause/factor statistical data are tabulated with respect to

a. Frequency of citation as cause and factor (Table 3-6)
b. Accident cost associated as cause and factor (Table 3-7).

These statistics are given for those cause/factors cited 13 or more times over the 1964 through 1976 time period (a citation rate of at least once per year). Corresponding statistical tables showing frequencies and costs for all 49 cause/factors listed in Table 3-4 are given in Appendix A.

TABLE 3-4. INDIVIDUAL AND AGGREGATE CAUSE/FACTORS USED IN THE SAFETY PROGRAM ANALYSIS AND EVALUATIONS

C/F Code	Description
64*01	Decision (pilot)
64*02	Execution (pilot)
64*03	Cognition (pilot)
64*04	Physical Incapacitation
65*01	Decision (co-pilot)
65*02	Execution (co-pilot)
65*03	Cognition (co-pilot)
66*02	Execution (dual student)
67*01	Decision (check pilot)
68*D0	Improper Maintenance (personnel)
68*D4	Inadequate Inspection of Aircraft (personnel)
68*D6	Inadequate Maintenance and Inspection (personnel)
68*G9	Air Traffic Control (personnel, other)
68*J0	Production-Design (substandard quality control)
68*K1	Ground signalman
68*K3	Ground crewman
68*K4	Passenger
68*K0	Pilot of Other Aircraft
68*R	Flight Attendant
68*R0	Flight Personnel (flight attendant)
68*00	Personnel (all others)
68*K9	Miscellaneous Personnel
70*CA	Landing Gear (Main shock assembly structures)
70*CB	Landing Gear (retraction/extension assembly)
70*CC	Landing Gear (emergency extension assembly)
70*CE	Landing Gear (nosewheel assembly)
70*CF	Landing Gear (wheels, tires, axles)
70*CJ	Landing Gear (braking system-normal)
70*CM	Landing Gear (gear locking mechanism)
70*00	Landing Gear (all other)
74*AD	Engine Structure (cylinder assembly)
74*ME	Compressor Assembly (disc compressor rotor)
74*00	Power Plants (recip./turbojet)
75*BD	Hydraulic System (reservoir, lines, fittings)
75*00	Systems (electrical, hydraulic, flight control, etc.)
76*00	Instruments/ Equipment and Accessories
78*00	Rotocraft
80*BA	Airport Condition (wet runway)
80*00	Airport/Airways Facilities (all other)
82*B	Rain
82*H	Unfavorable Wind Conditions
82*K	Clear Air Turbulence
82*L	Turbulence in Flight (assoc. clouds/thunderstorms)
82*X	Thunderstorm Activity
82*00	Weather (all other)
84*7	Evasive Maneuvers to Avoid Collision
84*I	Undetermined Cause
84*J	Written Cause
84*00	Miscellaneous

TABLE 3-5. NEW CODE DESIGNATIONS FOR AGGREGATION OF LOW FREQUENCY INDIVIDUAL CAUSE/FACTOR CODES

Category Description	Aggregated Cause/Factor Codes
All Personnel	68*00
" Airframe	70*00
" Powerplants	74*00
" Systems	75*00
" Instruments/Equipment	76*00
" Rotorcraft	78*00
" Airports/Airways	80*00
" Weather	82*00
" Other Miscellaneous	84*00

TABLE 3-6. FREQUENCY OF CAUSE/FACTOR CITATION AND ASSOCIATED COSTS RANKED BY CITATION AS CAUSE
(Costs are in thousands of 1974 dollars)

Code	Frequency As Cause	Frequency As Factor	Associated Cost As Cause	Associated Cost As Factor	Associated Total Cost
64*02	213	20	$138,960	$4,926	$143,886
64*01	155	32	90,039	9,723	99,762
82*L	112	6	20,941	2,334	23,275
68*K4	70	5	11,864	74	11,938
82*K	63	4	5,489	23	5,512
74*00	60	1	25,656	154	25,810
84*J	53	--	99,562	--	99,562
68*00	48	30	9,407	1,549	10,956
65*02	42	2	19,059	513	19,572
68*R	40	2	1,943	148	2,091
64*03	32	1	35,144	1	35,145
75*00	30	9	12,969	913	13,882
68*K0	29	6	41,174	120	41,294
82*00	25	118	26,640	36,841	63,481
68*D6	25	2	6,085	7	6,092
68*D0	24	3	3,468	50	3,518
70*00	21	7	15,308	3,350	18,658
84*00	20	5	36,525	116	36,641
70*CE	19	--	1,615	--	1,615
70*CA	18	--	3,718	--	3,718
70*CB	18	1	1,182	--	1,182
80*00	18	19	3,002	3,089	6,091
84*I	15	--	54,939	--	54,939
68*D4	14	1	750	40	790
68*K3	13	2	3,451	75	3,526
70*CF	13	--	2,463	--	2,463
66*02	13	--	2,621	--	2,621

TABLE 3-7. FREQUENCY OF CAUSE/FACTOR CITATION AND ASSOCIATED COSTS RANKED BY ASSOCIATED COST AS CAUSE (Costs are thousands of 1974 dollars)

Code	Associated Cost as Cause	Associated Cost as Factor	Total Associated Cost	Frequency as Cause	Frequency As Factor
64*02	$138,960	$4,926	$143,886	213	20
84*J	99,562	--	99,562	53	--
64*01	90,039	9,723	99,762	155	32
84*I	54,939	--	54,939	15	--
68*K0	41,174	120	41,294	29	6
84*00	36,525	116	36,641	20	5
64*03	35,145	--	35,145	32	1
64*04	28,780	4,276	33,056	7	2
82*00	26,640	36,841	63,481	25	118
74*00	25,656	154	25,810	60	1
82*L	20,941	2,334	23,275	112	6
65*02	19,059	513	19,572	42	2
82*X	16,980	1,821	18,801	12	27
70*00	15,308	3,350	18,658	21	7
75*00	12,969	913	13,882	30	9
68*G9	11,874	11,844	23,718	8	11
68*K4	11,864	74	11,938	70	5
70*CJ	11,574	13	11,587	7	1
68*00	9,407	1,549	10,956	48	30
84*7	8,561	350	8,911	12	1
82*B	7,951	11,631	19,582	6	27
68*D6	6,085	7	6,092	25	2
82*K	5,489	23	5,512	63	4
78*00	4,760	--	4,760	3	--
82*H	4,663	434	5,097	7	18
68*J0	4,262	--	4,262	6	--
70*CA	3,718	--	3,718	18	--
68*D0	3,468	50	3,518	48	30
68*K3	3,451	75	3,526	13	2
74*ME	3,069	--	3,069	8	--
80*00	3,002	3,089	6,091	18	19
66*02	2,621	--	2,621	13	--
70*CF	2,463	--	2,463	13	--
65*03	2,228	--	2,228	4	--
68*R	1,943	148	2,091	40	2
70*CE	1,615	--	1,615	19	--
70*CB	1,182	--	1,182	18	1

showing frequencies, costs and deaths/injuries for all 49 cause/factors listed in Table 3-3 are given in Appendix A.

In Table 3-6, the dominant cause/factors are ranked in descending order of frequency of citation as an accident cause. It is seen from this cause/factor ranking that human error citations stand out. Of a total of 1,203 citations as cause, 720 (60 percent) are human error; moreover, pilot/crew error accounted for 455 (38 percent) of all these citations as cause. Weather causes are the second most frequently cited category accounting for 200 (17 percent) of all citations as cause. Turbulence in flight and clear air turbulence were cited 175 (15 percent) times over the 13 year period. Mechanical cause/factors, including airframe, powerplants, systems and instruments/equipment, were cited 227 (19 percent) times as cause.

In Table 3-7, the dominant cause/factors are ranked in descending order of accident cost associated as cause. This ranking does not deviate significantly from that in Table 3-6. Of a total associated cost of $776 million, human error accounts for $444 million (51 percent), and pilot/crew errors accounted for $336 million (39 percent). Further, weather cause/factors account for $136 million (16 percent) of costs associated as cause. Similarly, mechanical cause/factors account for $86.7 million (10 percent) of costs as cause.

Finally, Table 3-8 shows the distribution of accidents costs associated with "unwritten cause" (code 84*J). There is a provision within the NTSB's MCC to write in a cause of an accident that cannot be accurately described by the coding system. The written entry usually cites the major cause/factor code area in which the cause occurred and a brief summary description. Using this written entry section in the individual accident records, the cause/factor occurrences and associated losses were distributed among the other major code categories.

TABLE 3-8. DISTRIBUTION OF ACCIDENT COSTS ASSOCIATED WITH WRITTEN CAUSE (CODE 84*J)

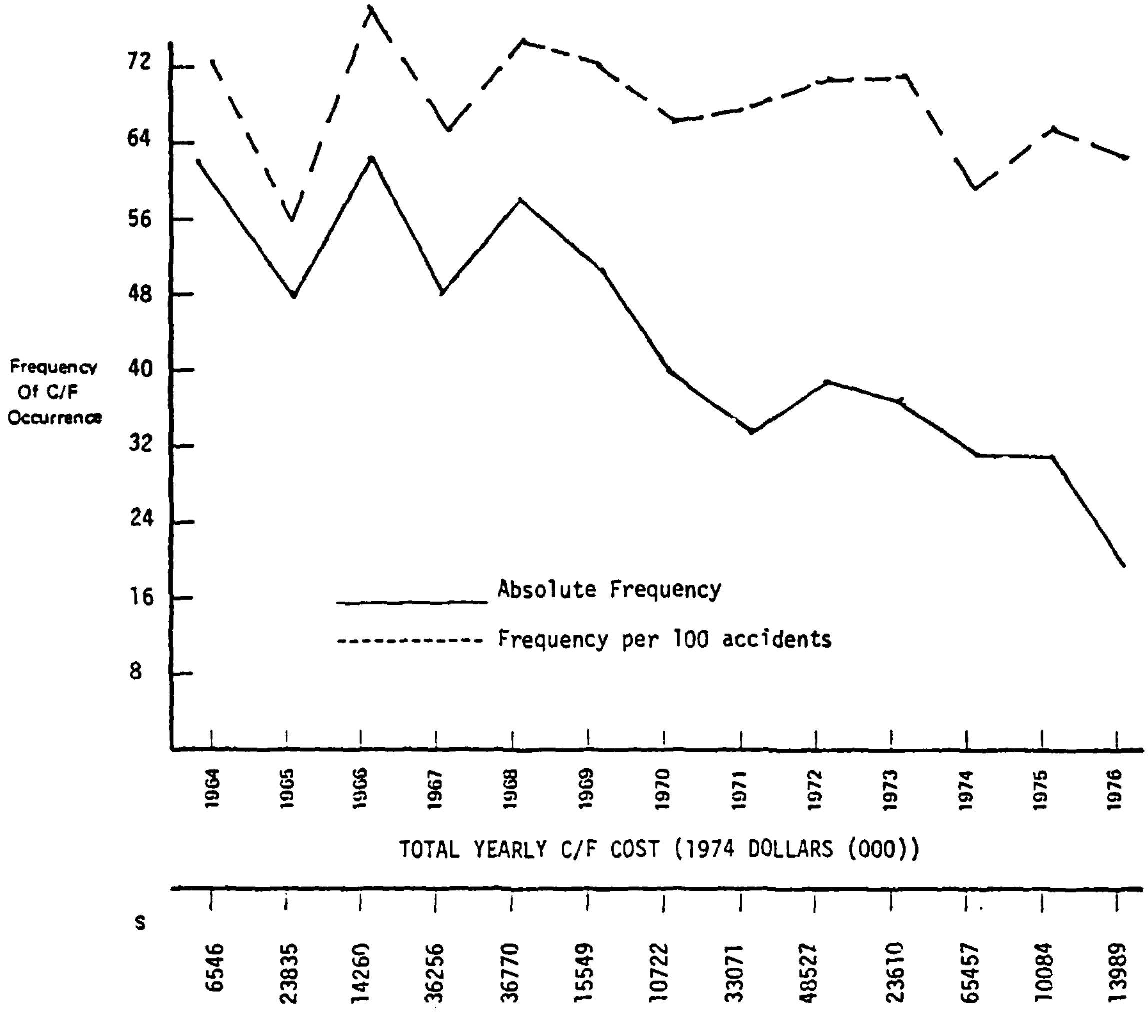
Total Cause Occurrences 53
Total Associated Deaths 479
Total Associated Dollar Loss (1000's) $99,562

Major Code Categories	Occurrences	Associated Dollar Loss (000)
64 (Pilot/crew)	23	$51,074
68 (Personnel)	7	10,958
70 (Airframe)	3	1,210
74 (Power Plant)	1	670
75 (Systems)	3	5,924
76 (Instruments/Equipment)	1	5,166
78 (Rotorcraft)	1	1,239
80 (Airport/Airways)	1	75
82 (Weather)	1	670
84 (Miscellaneous)	12	22,509

Major Cause/Factor Category Statistical Summaries. All of the cause/factor data (frequency of occurrence, costs, fatalities, etc...) for the major code categories shown in Table 3-8 are summarized in Figures 3-2 through 3-11. A special designation was created for the aggregation of the data concerning the 49 individual cause/factors shown in Table 3-4. This code designation is *99 and its use with a major code category, for example 74*99, represents the total 13 year data history for category 74 (Power Plant Causes). This aggregation provided a means for examining what impact various programs may have had on the prevalence of specific accident causes. The corresponding statistical data for the 49 individual cause/factors (with the exception of code 84*J) which make up these summaries are presented in Appendix B.

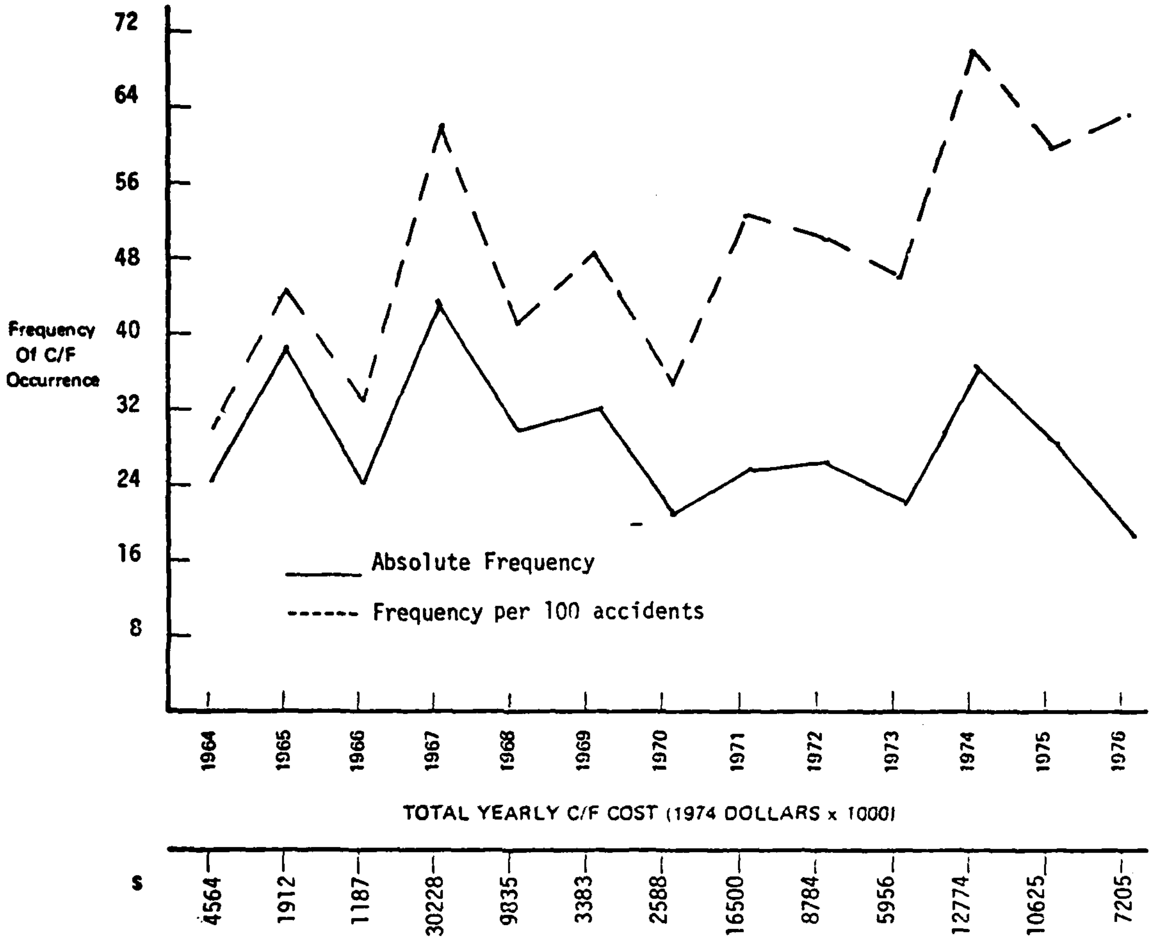
For the relative high frequency major cause/factor categories (pilot/crew, personnel and weather), the time series plots show that:

a. The pilot/crew error frequency rate has decreased approximately 70 percent over the 13 year period. However, the corresponding rate per 100 accidents has remained constant (Figure 3-2).



TOTAL ASSOCIATED FATALITIES	3,133
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . .	495
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . .	61
TOTAL ACCIDENTS	556
TOTAL ASSOCIATED COST AS CAUSE	369,213
TOTAL ASSOCIATED COST AS FACTOR	20,535
TOTAL ASSOCIATED COST	389,748

FIGURE 3-2. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: PILOT/CREW ERROR (CODES 64-67*39)

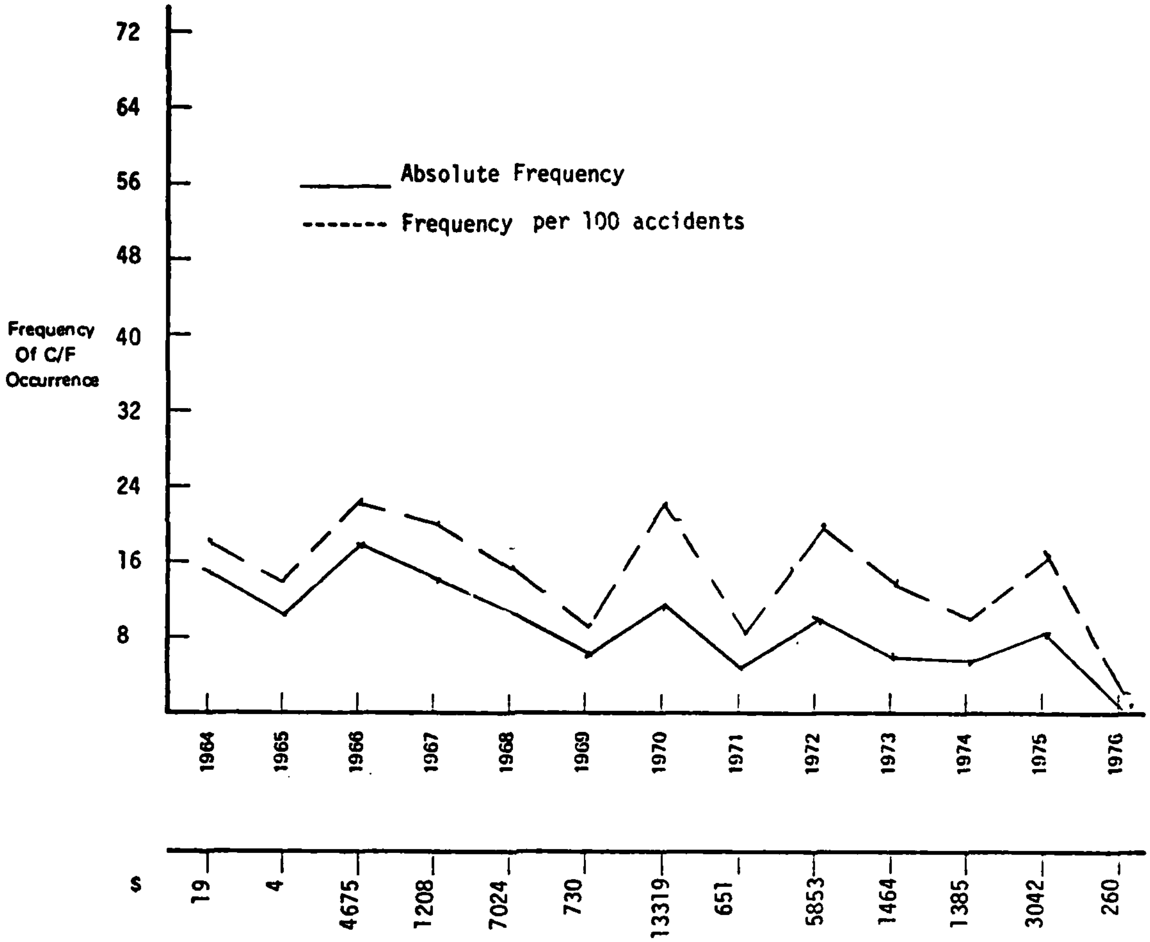


TOTAL ASSOCIATED FATALITIES 1,206

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 303
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 76
TOTAL ACCIDENTS 379

TOTAL ASSOCIATED COST AS CAUSE 106,705
TOTAL ASSOCIATED COST AS FACTOR 19,794
TOTAL ASSOCIATED COST 126,499

FIGURE 3-3. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL PERSONNEL (CODE 68*99)



TOTAL ASSOCIATED FATALITIES 374

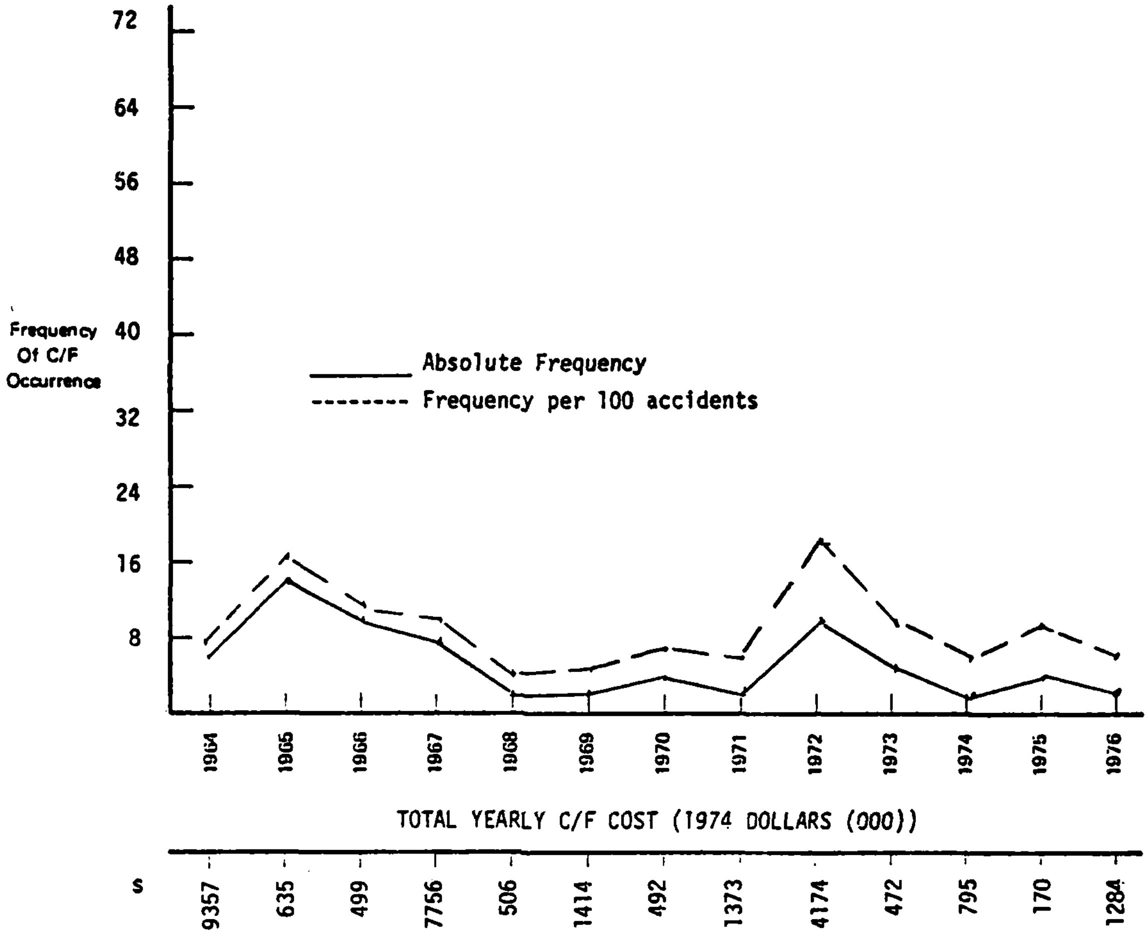
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 115
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 10

TOTAL ACCIDENTS 125

TOTAL ASSOCIATED COST AS CAUSE 36,318
TOTAL ASSOCIATED COST AS FACTOR 3,436

TOTAL ASSOCIATED COST. 39,754

FIGURE 3-4. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL AIRFRAME (CODE 70*99)

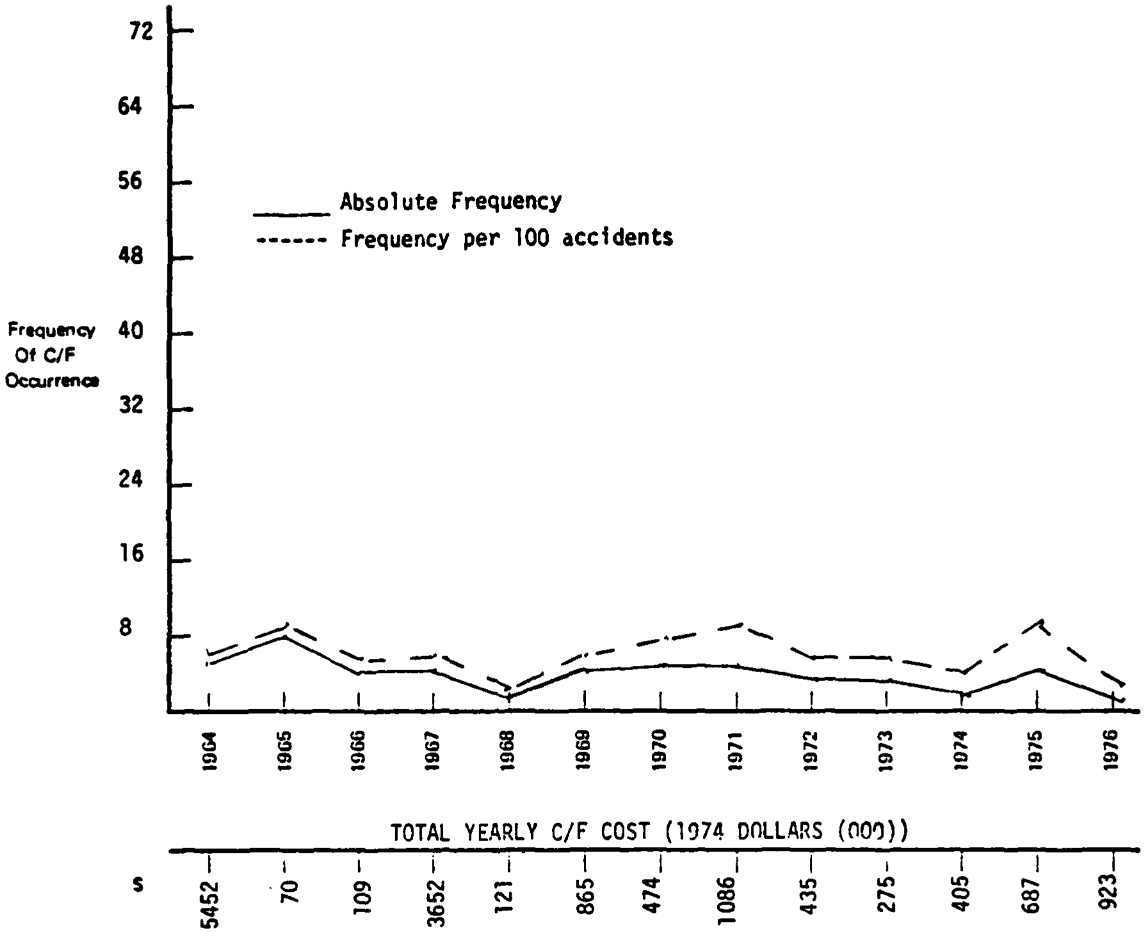


TOTAL ASSOCIATED FATALITIES 153

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . . 75
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 2
TOTAL ACCIDENTS ASSOCIATED 77

TOTAL ASSOCIATED COST AS CAUSE 29,443
TOTAL ASSOCIATED COST AS FACTOR. 154
TOTAL ASSOCIATED COST. 29,597

FIGURE 3-5. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL POWER PLANTS (CODE 74*99)



TOTAL ASSOCIATED FATALITIES. 158

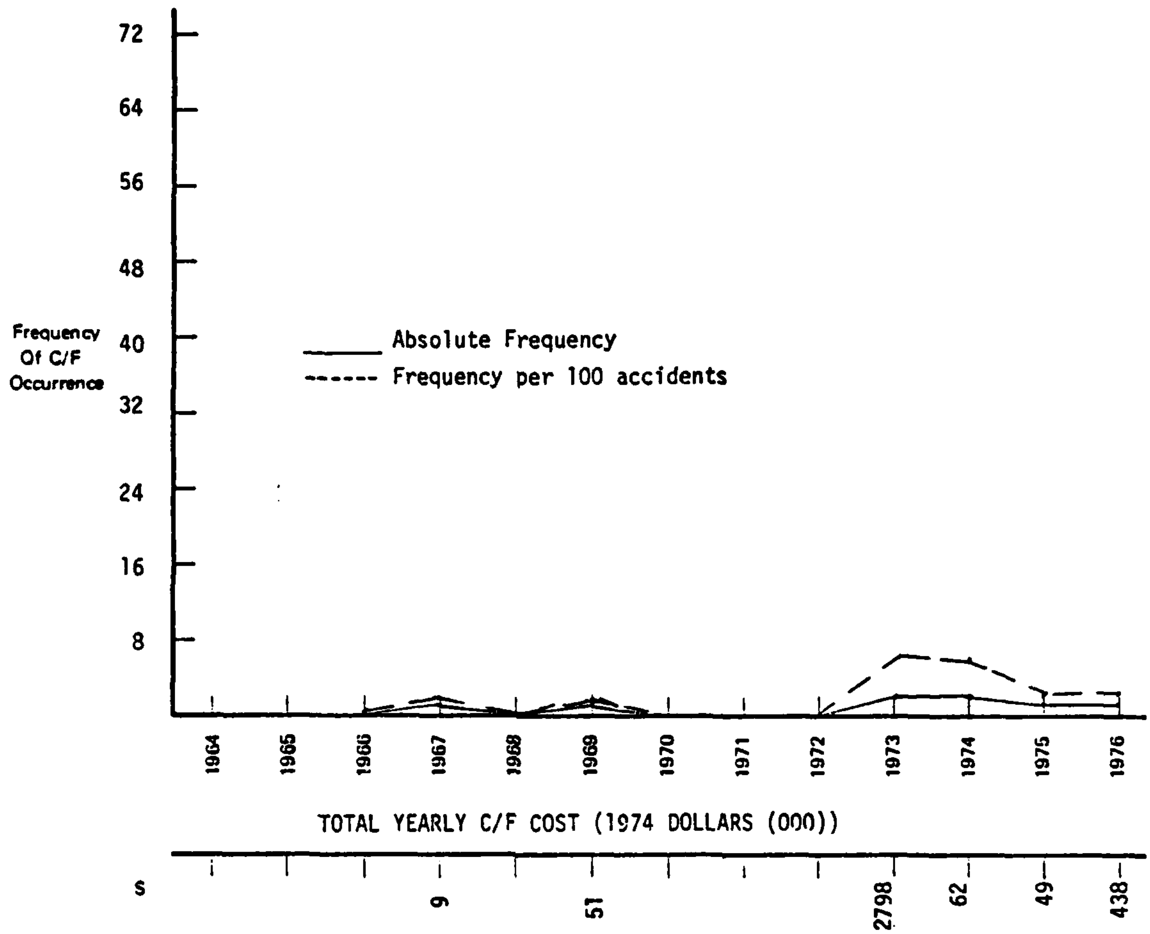
TOTAL ACCIDENTS ASSOCIATED AS CAUSE 40
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 14

TOTAL ACCIDENTS 54

TOTAL ASSOCIATED COST AS CAUSE 19,268
TOTAL ASSOCIATED COST AS FACTOR 1,210

TOTAL ASSOCIATED COST 20,478

FIGURE 3-6. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL SYSTEMS (CODE 75*99)



TOTAL ASSOCIATED FATALITIES 88

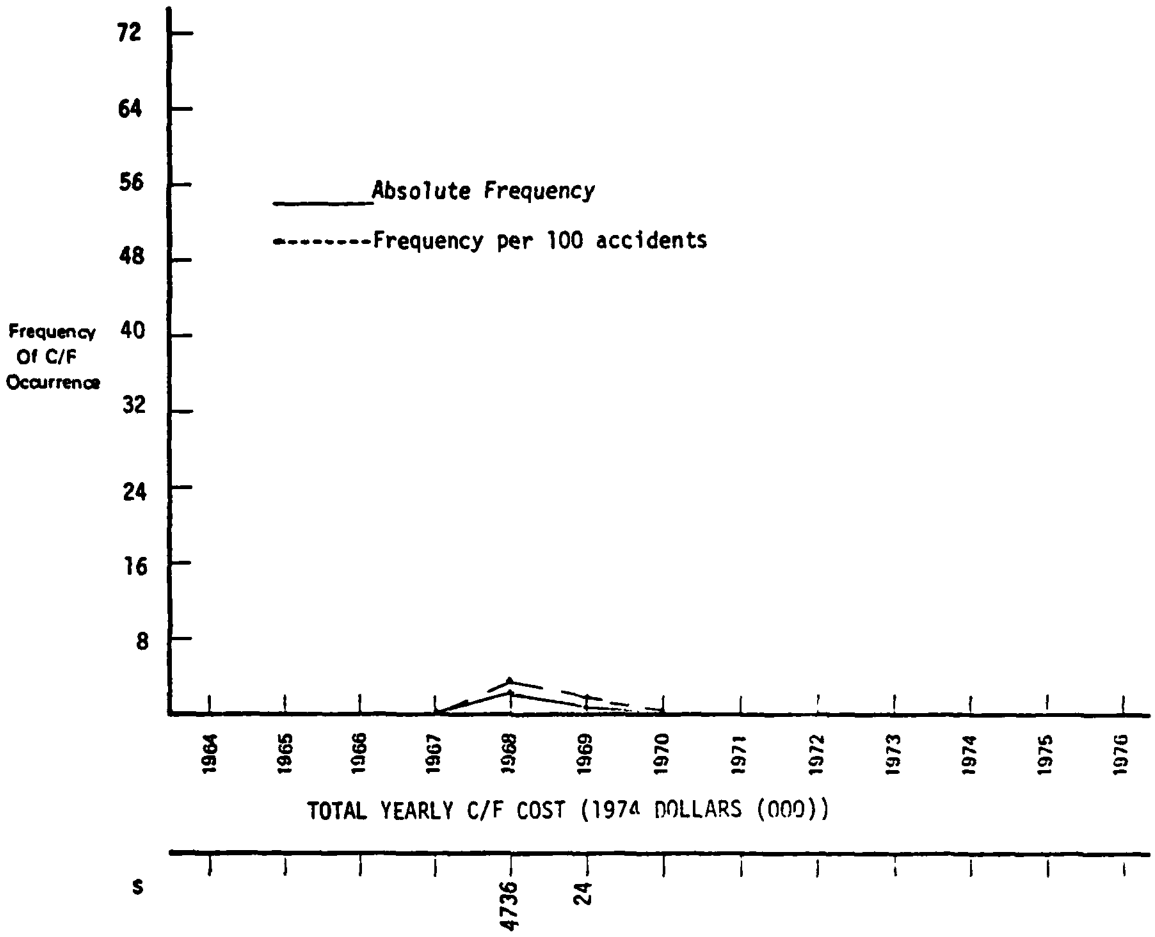
TOTAL ACCIDENTS ASSOCIATED AS CAUSE 5
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 6

TOTAL ACCIDENTS. 11

TOTAL ASSOCIATED COST AS CAUSE 5703
TOTAL ASSOCIATED COST AS FACTOR 2870

TOTAL ASSOCIATED COST. 8573

FIGURE 3-7. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL INSTRUMENTS/EQUIPMENT (CODE 76*99)

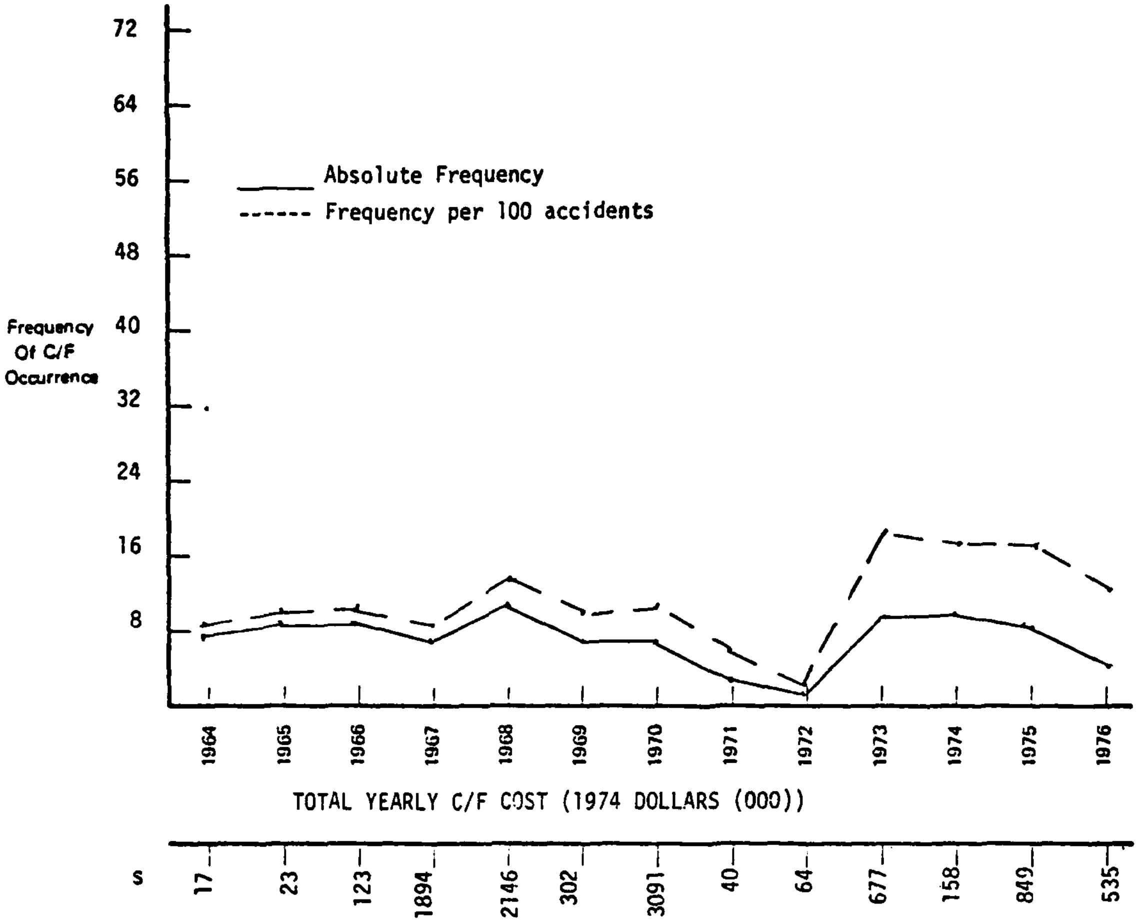


TOTAL ASSOCIATED FATALITIES. 44

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . . 4
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . .
TOTAL ACCIDENTS ASSOCIATED AS BOTH 4

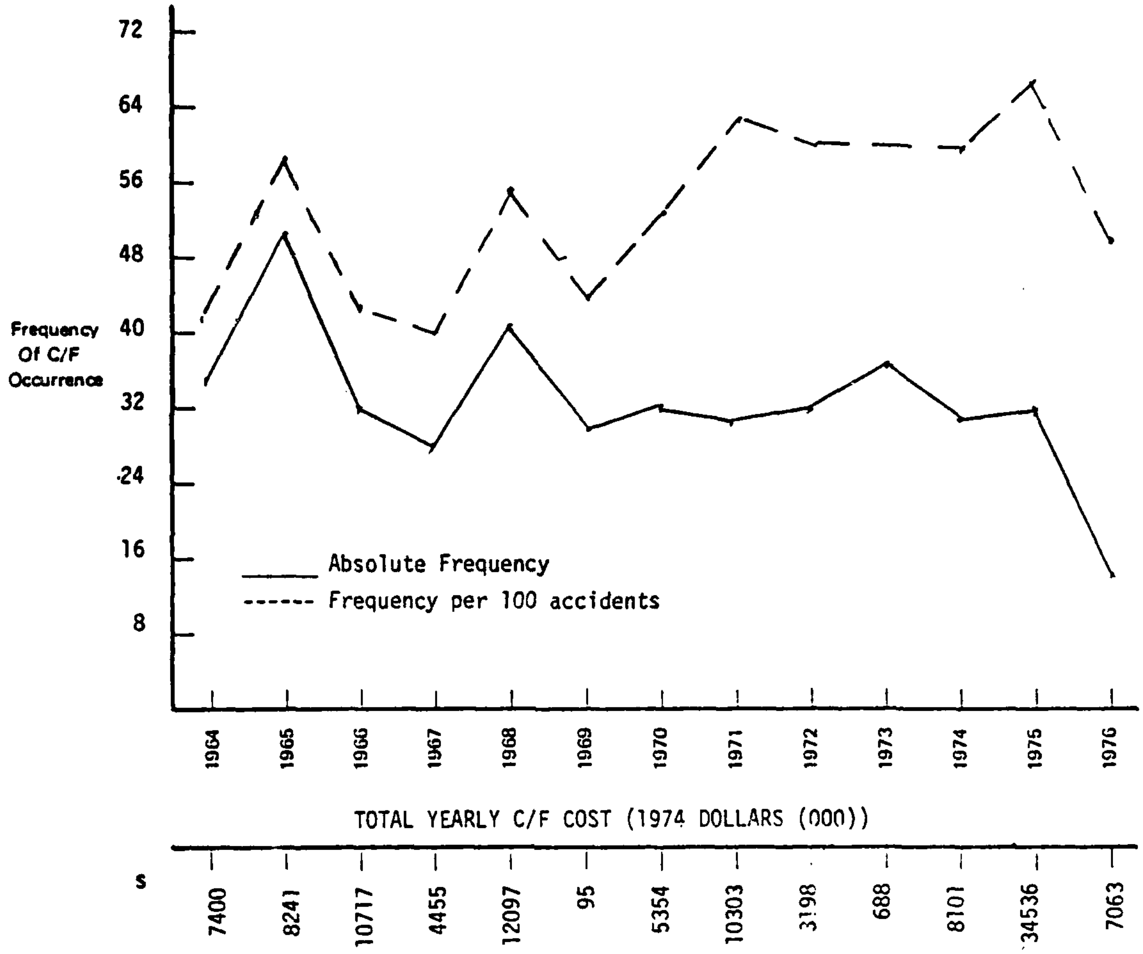
TOTAL ASSOCIATED COST AS CAUSE	5999
TOTAL ASSOCIATED COST AS FACTOR	--
TOTAL ASSOCIATED COST AS BOTH	5999

FIGURE 3-8. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL ROTORCRAFT (CODES 78*90)



TOTAL ASSOCIATED FATALITIES.	142
TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . .	28
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . .	57
TOTAL ACCIDENTS	85
TOTAL ASSOCIATED COST AS CAUSE	3884
TOTAL ASSOCIATED COST AS FACTOR	6109
TOTAL ASSOCIATED COST	9993

FIGURE 3-9. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL AIRPORT/AIRWAYS (CODE 80*99)

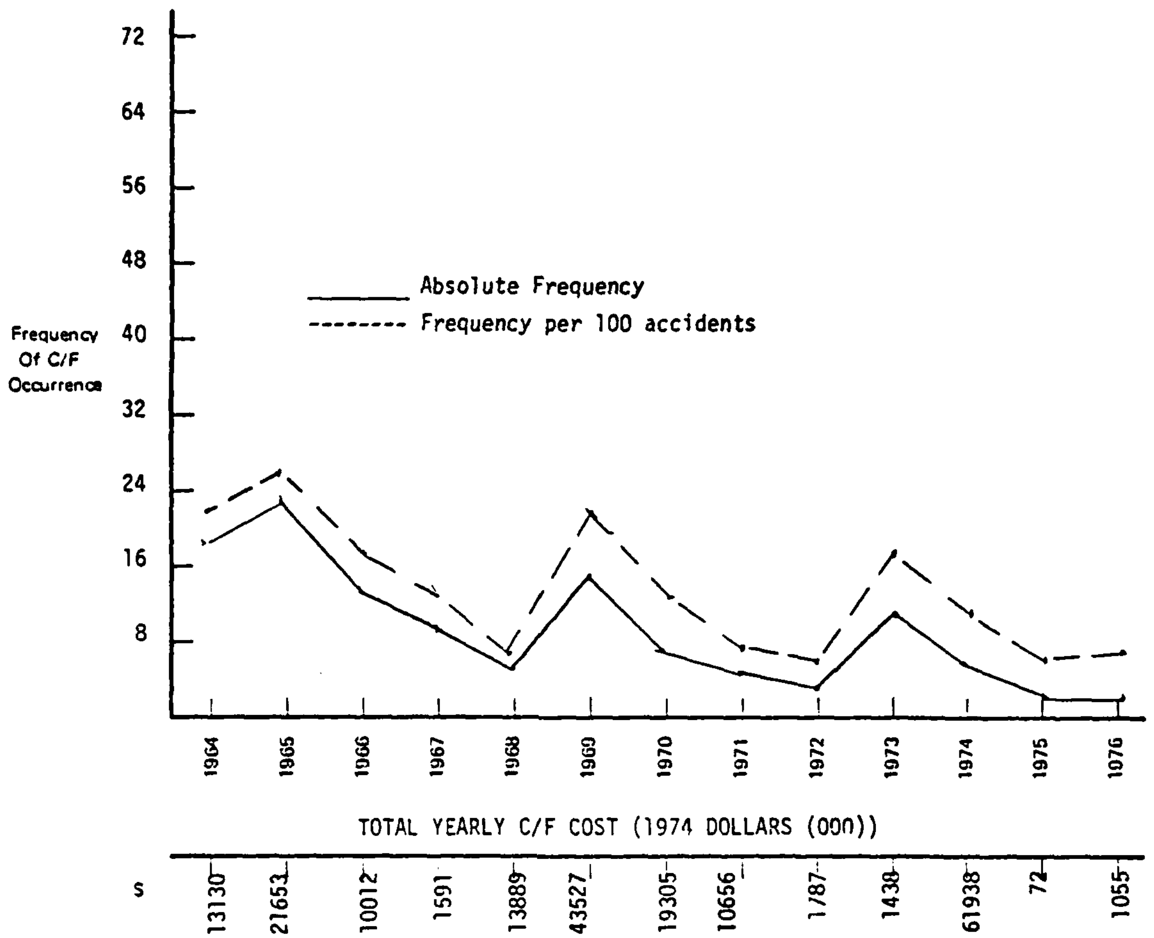


TOTAL ASSOCIATED FATALITIES 2,634

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 226
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 200
TOTAL ACCIDENTS 426

TOTAL ASSOCIATED COST AS CAUSE 83334
TOTAL ASSOCIATED COST AS FACTOR 53084
TOTAL ASSOCIATED COST. 136418

FIGURE 3-10. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: ALL WEATHER (CODE 82*99)



TOTAL ASSOCIATED FATALITIES. 1,073

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . . 112
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 6

TOTAL ACCIDENTS ASSOCIATED 118

TOTAL ASSOCIATED COST AS CAUSE 222,096
TOTAL ASSOCIATED COST AS FACTOR 466

TOTAL ASSOCIATED COST 222,562

FIGURE 3-11. CAUSE/FACTOR CATEGORY FREQUENCY AND COST SUMMARY: All Miscellaneous (Code 84*99)

AD-A085 347 BATTELLE COLUMBUS LABS OH F/G 13/12

EVALUATION OF SAFETY PROGRAMS WITH RESPECT TO THE CAUSES OF AIR--ETC(U)

JAN 80 T M CONNOR, C W HAMILTON DOT-FA77WA-4072

UNCLASSIFIED FAA-ASP -80-1 NL

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b. The personnel cause/factor frequency rate has remained constant in absolute terms, but has increased approximately 100 percent in relative terms (Figure 3-3).

c. The weather cause/factor frequency rate appears to have changed only slightly downward except for a significant decrease in 1976. On the other hand, in frequency per 100 accidents, the rate has increased approximately 40 percent over the 13 year period (Figure 3-10).

The relatively low frequency major cause/factor categories, airframe (Figure 3-4) and miscellaneous (Figure 3-11), exhibit slight downward trends in both absolute and relative terms. The remaining categories (power plant, systems, instruments/ equipment, rotorcraft, and airports/airways) show no significant trends.

CAUSE/FACTOR AND SAFETY PROGRAM ALIGNMENT ANALYSIS

As described in Chapter 2.0, this analysis consists of aligning cause/factors against

a. *The objectives of FAA safety programs*

b. NTSB safety recommendations

c. Facilities/equipment identified by the FAA as possible accident preventors.

The results of this three-part alignment analysis are described in following sections of this chapter.

Alignment of FAA Safety Programs with Cause/Factors

This analysis consists of aligning the 49 cause/factors listed in Table 3-4 (Page 3-6) against the objectives of the 90 FAA safety programs listed in Tables 2-10 through 2-15 (pages 2-30 through 2-34) in accord with the direct/indirect alignment criteria defined in Chapter 2.0 (page 2-1). As described earlier in Chapters 2.0 and 3.0, these cause/factors include the substitute behavioral codes (cognition, execution and decision) in the pilot/crew major categories, exclude the terrain (code 83) and miscellaneous acts and conditions (code 88) used as qualifiers, and, where required, represent aggregation of low frequency cause/factors within major categories. The 90 FAA safety

programs are categorized by type as described in the data base section of Chapter 2.0. These program categories are: facilities and equipment (100), safety research and development (200), operations safety (300), regulatory (400), capacity programs with safety contributions (500) and management and administrative programs with safety contributions (600).

The alignment criteria address the question, is there a one-to-one correspondence between the specific objective of a safety program and the hazard associated with a cause/factor definition (direct alignment), or is there a more general correspondence in which the hazard associated with a cause/factor is subsumed within the context of a broader safety program objective (indirect alignment)? In short, the alignments given in this section are qualitative statements of the degree of congruence between program objectives and cause/factor hazards.

Application of these criteria yielded the cause/factor and safety program alignments shown in Table 3-9 (and the cause/factor statistical summaries in Appendix B). Examination of the direct and indirect alignments shown in Table 3-10 reveals the following summary observations:

a. 58 of the 90 FAA safety programs were aligned against 45 of the 49 cause/factors. The majority of these alignments were determined to be indirect. Specifically, 16 programs were directly aligned against 16 cause/factors and 50 programs were indirectly aligned against 29 cause/factors (some programs were aligned both directly and indirectly).

b. 8 of the 16 directly aligned safety programs are in the safety R&D category (200) and typically entail a narrowly defined program addressing a well-defined hazard. For example, the conflict alert (202) and collision avoidance system/proximity warning indicator (206) programs are specifically directed toward the midair collision hazard implied by the cause/factor, evasive maneuvers to avoid collision (code 84*7). The other 8 directly aligned programs are in the operations safety, regulatory and facilities/equipment categories; and, similarly address well-defined hazards associated with detailed cause/factors.

c. 30 of the 50 indirectly aligned programs are in the regulatory (400) and safety R&D (200) program categories. The other 20 indirect alignments consist of 7 programs in the facilities/equipment (100) and in operations safety (300) categories, and 3 programs in the capacity with safety

TABLE 3-9. SAFETY PROGRAM AND CAUSE/FACTOR ALIGNMENTS

	Aligned Safety Programs(2)	
C/F Code(1)	Direct Alignment	Indirect Alignment
64*01(3)	None	221,302,412
*02	218	106-109,111,115,205,214,220,221
*03	310	202,206,223
*04	222,415	None
68*00	None	102,103,224,311-313,402,411 413-415,419,422,601,607
*D0	411	None
*D4	411	419
*D6	411	419
*G9	None	224, 313
*K0	None	202, 206, 223
*K1	None	419,422
*K3	None	419
*K4	307	401
*J0	305	308,602
*R and R0	307	401,419
70*00	None	305,308,402,404,409,411
*CA,CB,CC,CE,EF,CJ,CM	None	305,308,402,406
74*00	None	305,308,402,407,408,409,411
*AD,ME	None	308,407
75*00	None	305,308,402,409,411
*BD	None	308,402,406
76*00	None	305,308,402,409,411
78*00	None	305,308,402,405,409,411
80*00	209	115,311,422,502,504,505
*BA	117	422
82*00	219	102,103,203,207,225,301
*H	216	102,103
*L	None	203,225,416
*X	301	416,419
84*00	212,303	216,418,422
*7	202,206	201

(1) Cause/Factor code descriptions are given in Table 3-4

(2) Program descriptions are given in Table 2-10 through 2-15.

(3) Code 64* represents the three other "pilot error" categories 65,66, and 67.

contribution (500) and in the management administration (600) program categories. Further, as implied by the indirect alignment criterion definition, an individual program is typically aligned with several cause/factors. For example, the maintenance analysis center program (308) is aligned with 16 cause/factors in the personnel (code 68), mechanical (codes 70, 74, 75, 76) and rotorcraft (code 78) major categories. This alignment multiplicity is examined further in the evaluation of interconnected sets of safety programs against associated cause/factor combinations.

There are 30 safety programs that were not aligned with any of the 49 cause/factors. These programs are listed in Table 3-10. Twenty-three of these programs are further tested for alignment with NTSB safety recommendations described in the following section. The remaining seven programs concern general aviation and, therefore, are considered within the scope of the study.

In addition, as shown in Table 3-10, there are four cause/factors that could not be aligned with safety programs. The miscellaneous personnel cause/factor (code 68*K9) did not align with a safety program because the specific cause is undeterminable. Undetermined cause (code 84*I) is a collector code for unsolved accidents and, hence, its nature prohibits alignment. Rain (code 82*B) could not be aligned because no program was specifically directed at this hazard. This cause/factor was cited mainly as a qualifier. In accidents where its effects (e.g., wet runway, hydroplaning, low visibility, etc.) were responsible, rain was also cited as a probable cause. Clear air turbulence (code 82*K) is examined further in the program evaluations section of this report.

Alignment of FAA Safety Programs with NTSB Safety Recommendations

One problem in aligning safety programs with accident causes is that some programs deal with the effects of a certain cause/factor rather than the cause itself. The Frangible Approach Light Mounting Retrofit program (110) illustrates this program and cause/factor relationship. In this case, the NTSB was concerned with passenger survivability from either failed landings or aborted takeoffs where the plane left the runway and collided with a lighting system. The result of the research recommended by the NTSB was a

TABLE 3-10. SAFETY PROGRAMS AND CAUSE/FACTORS NOT ALIGNED

	Facilities/ Equipment (100)	Safety R&D (200)	Operations Safety (300)	Regulatory (FARs) (400)	Capacity With Safety Contributions (500)	Management/ Administration With Safety Contributions (600)
Safety Program Not Aligned	105 110 112 113 114 116 118	204 208 210 211 213 215 217	306	417 420	501 503 507	604 605 606
General Aviation Safety Program Not Considered	101 104		304	403 421	506	603
Cause/Factors Not Aligned		68*K9 (Misc.Personnel - Other) 82*B (Rain 82*K (Clear Air Turbulence) 84*I (Undetermined Cause)				

mounting system that yielded on impact, thus reducing the likelihood of more severe aircraft damage and passenger injuries. The alignments reported in this section generally entail corollary relationships between safety programs and cause/factors as exemplified by the above example.

As described in Chapter 2.0, the NTSB safety recommendations are cataloged in a computer file (SAREC), and are divided into five categories as shown in Table 3-11. This table also shows the categorical distribution of 477 recommendations in the SAREC file that were made by the NTSB between January, 1968 and March, 1978. The alignments of FAA safety programs with these recommendation categories are shown in Table 3-12, The ten safety program alignments shown in this table involve hazardous materials (210 and 306), crash and fire rescue (208 and 211), traffic management (215, 503 and 507), crashworthiness (213), the frangible approach lighting mounting retrofit program (110) and cabin safety (306 and 307).

TABLE 3-11. DISTRIBUTION OF NTSB SAFETY RECOMMENDATIONS

Recommendation Category	Recommendation Distribution (percent)
Airworthiness Directives, etc.	27
Testing and Research	12
Cabin Safety	5
Review of Procedures, etc.	48
Miscellaneous	8

TABLE 3-12. SAFETY PROGRAM ALIGNMENTS WITH NTSB RECOMMENDATION CATEGORIES

Recommendation Category	Aligned Safety Programs
Airworthiness Directives, etc.	none
Testing and Research	208, 210, 211, 213
Cabin Safety	306, 307
Review of Procedures, etc.	215, 503, 507
Miscellaneous	110

In sum, 68 of the 90 FAA safety programs are aligned against cause/factors or NTSB safety recommendations in the SAREC computer data base. Of the 22 remaining programs, seven are general aviation oriented, and, hence, not considered in this study. Fourteen programs could not be aligned. These programs are identified in Table 3-13. It should be noted that an unaligned program should not be interpreted as having no impact on air carrier systems safety. Unalignment means simply that, no accident has occurred (possibly, because of the program) that relates to the program objective.

TABLE 3-13. SAFETY PROGRAMS NOT ALIGNED WITH ANY CAUSE/FACTOR OR NTSB SAFETY RECOMMENDATION

Computer Code	Description of Program
105	Equip VORs with DME
112	BRITE
113	ARTS II
114	ASR - 8
116	Simplex Radar
204	ATARS
217	DABS
118	EARTS/DARC
417	FAR Part 93
420	FAR Part 123
501	National ATCSCC
604	Automation of Instrument Flight Procedures Review
605	Review of TCA Establishment Procedures
606	Review of TRSA Establishment Procedures

Accident Preventor Assignments

As part of the process of examining the individual accident records, judgments were made concerning the possible prevention of accidents had selected facilities/equipment been available. These facilities/equipment were provided by the FAA as a list of potential accident preventors, and are described in

Table 2-16. The results given in Table 3-14 are based on review of 631 accidents from January, 1966 to December 1976. Applicability of these preventors was judged conservatively and without regard to economic feasibility. On a case-by-case basis, it was necessary to establish that the aircraft and pilot were capable of making use of preventor facilities/equipment (for example, ILS-CAT Systems). For many cases, the particular system acting potentially as an accident preventor was already available at the time of the accident, but apparently was of no value in its prevention. Of the 631 accident records examined, an accident preventor was assigned in 80 (13 percent) cases. The high number of assignments (46) of accident preventor 807 (Full ILS-CAT III) reflects the fact that the majority of aircraft accidents occurs during the landing phase. However, more than 21 or these Code 807 assignments were at unimproved air fields in Alaska.

TABLE 3-14. FAA ACCIDENT PREVENTOR (EQUIPMENT AND FACILITIES) ASSIGNMENTS

Code Preventor	Number of Accidents
804 (Direction Finding)	1
805 (Weather Enroute)	3
806 (ATC-DABS/ATARS)	7 (Several Mid Airs)
807 (ILS/CAT)	46
808 (VASI)	2
811 (ASDE)	3 (Ground Collisions)
812 (Weather Facilities)	1
813 (Communication Facilities)	1
818 (WVAS)	1
819 (Wind Shear Detection)	4
820 (TCA)	1
821 (ARTS III)	10 (Several Mid Airs)

SAFETY PROGRAM EVALUATION

In the evaluation described in this section, the 90 FAA safety programs are examined as:

a. Individual programs
b. Members of a common group based on their interconnected objectives.
c. Members of a common group based on their approach to accident prevention.

Individual programs are examined with respect to their observed effectiveness in mitigating directly aligned cause/factor rates of occurrence. The common groups based on objectives or approach are examined jointly using the fault tree methodology described in Chapter 2.0. In making this evaluation, it should be noted that safety research and development programs (Code 200) represent possible future safety actions, but are not yet implemented. Thus, while these programs can be aligned with associated cause/factors, they can have no impact in mitigating these cause/factors at this time. Similarly, some safety programs in the other categories were implemented in the latter years covered in this study, and, hence, cannot be evaluated in terms of cause/factor mitigation over the entire 13 year study period.

Evaluation of Individual Programs

The evaluation of individual programs consists of relating temporal changes in cause/factor frequencies with the implementation dates of directly aligned safety programs. The alignment analysis identified 19 direct alignments involving 16 cause/factors and 16 safety programs. The frequencies and direction of change for these 16 cause/factors are shown in the time series plots in Table 3-15. Implementation dates for the 16 directly aligned safety programs are listed in Table 3-16.

It is seen from this table that only four of the 19 safety program and cause/factor pairs suggest any mitigating effectiveness. The three safety programs involved are:

a. FAR Part 43, Maintenance, Preventive Maintenance, Rebuilding Alterations (411). This program virtually eliminated improper maintenance (code 68*D0) and inadequate inspection (code 68*D4) cause/factors citations which had peaked in the mid-1960's.

b. Runway Grooving (117). This program is judged to be generally responsible for a gradual decline in airport condition (wet runway) (Code 80*BA) cause/factor citations.

c. Airport Security Programs (303). These programs are judged to be responsible for control of highjackings and other terrorist acts (subsumed in code 80*00) occurring in the early 1970's.

Six safety programs, implemented in 1975 or later, are too new to be reflected in the cause/factor data used in this study. The remaining seven directly aligned

TABLE 3-15. TEMPORAL TRENDS IN THE INDIVIDUAL CAUSE/FACTOR RATES OF CITATION

Cause/Factor Code	Frequency (1) of Occurrence	Trend: Absolute Frequency Change	Trend: Relative Frequency Change
64*02	High	Decrease	None
64*03	Low	None	None
64*04	Low	None	None
68*D0	Low	Decrease	Decrease
68*D4	Rare	None	None
68*D6	Low	None	None
68*K4	Moderate	Increase	Increase
68*J0	Rare	None	None
68&R0	Rare	None	None
68*R	Low	Increase	Increase
80*00	Low	None	Increase
80*BA	Low	Decrease	Decrease
82*00	High	None	Increase
82*H	Low	None	None
82*X	Low	None	None
84*00	Low	None	None
84*7	Low	None	None

(1) High: An average annual citation rate of more than 10.
Moderate: An average annual citation rate of 5 to 9.
Low: An average annual citation rate of 1 to 4.
Rare: An average annual citation rate of less than 1.

TABLE 3-16. SAFETY PROGRAM APPARENT EFFECTIVENESS IN MITIGATING CAUSE/FACTORS AGAINST WHICH THEY ARE DIRECTLY ALIGNED.(1)

Cause/Factor Code	Program Code	Program Implementation Year	Apparent Mitigation	Remarks
64*02	218	1977	None	New program
64*03	310	1976	None	New program
64*04	222		None	Low frequency C/F; no change
	415	1962	None	Low frequency C/F; no change
68*D0	411	1964	Positive	C/F peak (1964-66); virtually eliminated
68*D4	411	1964	Positive	C/F peak (1964-66); virtually eliminated
68*D6	411	1964	None	Low frequency C/F, no change
68*K4	307	1961	None	Moderate frequency C/F; slight increase
68*J0	305	1971	None	Rare occurence C/F
68*R, R0	307	1971	None	Low frequency C/F; slight increase
80*00	209	1968	None	Low frequency C/F; no change
80*BA	117	1972	Positive	Low Frequency C/F; decrease
82*00	219	1972	None	High frequency C/F; no change
82*H	216	1970	None	Low frequency C/F; no change
82*X	301	1977	None	New program
84*00	212	1976	None	New program
	303	1970,72	Positive	Low frequency; decrease in mid-1970's
84*7	202	1975	None	New program
	206	1975	None	New program

(1) Safety Research and Development Programs are not yet implemented, and, therefore, do not impact the NAS at this time (See Page 3-31).

safety programs are associated with low frequency cause/factors in which no trend or only a slightly increasing trend could be observed.

In sum, this evaluation of individual programs yielded few empirical indications of program effectiveness. However, it should be recognized that this finding mainly reflects statistical data limitations. Further evaluation of these programs using appropriate conceptual methods, as described in the following section, is required to support valid conclusions.

Evaluation of Safety Program Combinations

Evaluation of safety program combinations is predicated on the finding that the majority of FAA safety programs are indirectly aligned with associated cause/factors. These indirect alignments stem from differences in program or cause/factor scope. That is, a single program may address several cause/factors, or, conversely, a single cause/factor may be addressed by several programs. Two methods have been used in evaluating the effectiveness of such program combinations as described in Chapter 2.0:

a. An accident cause fault tree. The fault tree portrays the logical hierarchial relationships among accident causes. It is used in this study to determine the levels of aggregation of accident causes at which programs are directed and to identify the connectivity among programs with common objectives.

b. Classification of safety programs by approach to accident prevention. These classes of programs (operator assistance, monitoring, remedial, and safety standards) are used in conjunction with the fault tree to further explain the interconnectivity among safety programs.

In the following paragraphs, the combinatorial evaluation of safety programs is examined in detail in three cases, and is generalized with respect to all safety programs using the fault tree as the principal method.

Case Evaluation. Three complete descriptions of the cause/factor - safety program evaluations are described below; these descriptions illustrate the analysis process which the cited cause/factors underwent.

64*01 (Pilot-Decision Error). The pilot-decision error (Code 64*01) is an aggregation of 19 MCC codes that describe what a pilot did in an accident; but not why the pilot committed these errors. Examples of these descriptions include (Table 2-7):

a. (64*01) Attempted operation with known deficiencies in equipment.

b. (64*20) Failed to follow approved procedures, directives, or instructions.

c. (64*27) Improper in-flight decision or planning.

d. (64*33) Exercised poor judgment.

The substitute code, decision error, was selected to characterize an important attribute of pilot behavior and, to establish a more informative basis for defining needed research in this area. The severity of this cause/factor over 13 years of accident history is shown in Figure B-1 (Appendix B). This cause/factor frequency rate shows a significantly high rate of occurrence, especially when adjusted for accident rate. It is clear that decision error is a serious safety problem.

There are no safety programs directly aligned with this cause/factor, nor correspondingly, with any of the descriptive citations listed in the MCC. There are, however, three indirectly aligned safety programs. These are Pilot Training Research (221), FAR Part 121 Certification and Operations--Air Carrier and Operators of Large Aircraft (419), and FAR Part 61, Pilot and Flight instructors (412). These three programs direct some attention to certain aspects of requiring and developing a pilot's decision making capacity skills, but at varying accident levels; the programs appear to lack coordination of objectives or approach. This judgment follows from examining the human cause fault tree chain in Figure 3-12. Tracing the hierarchy of several cause/effect chains led to the identification of possible fundamental accident causes. In the example fault tree, thus, given "complete" accident investigation data, one specific path could be identified leading to, say, fatigue as the cause of the accident. That is, assuming the chain was complete, the "first cause" (fatigue) could be empirically confirmed as precipitating the accident. A safety program directly aligned with the first cause would deal exclusively with either detecting eliminating or reducing fatigue of the type that causes these accidents.

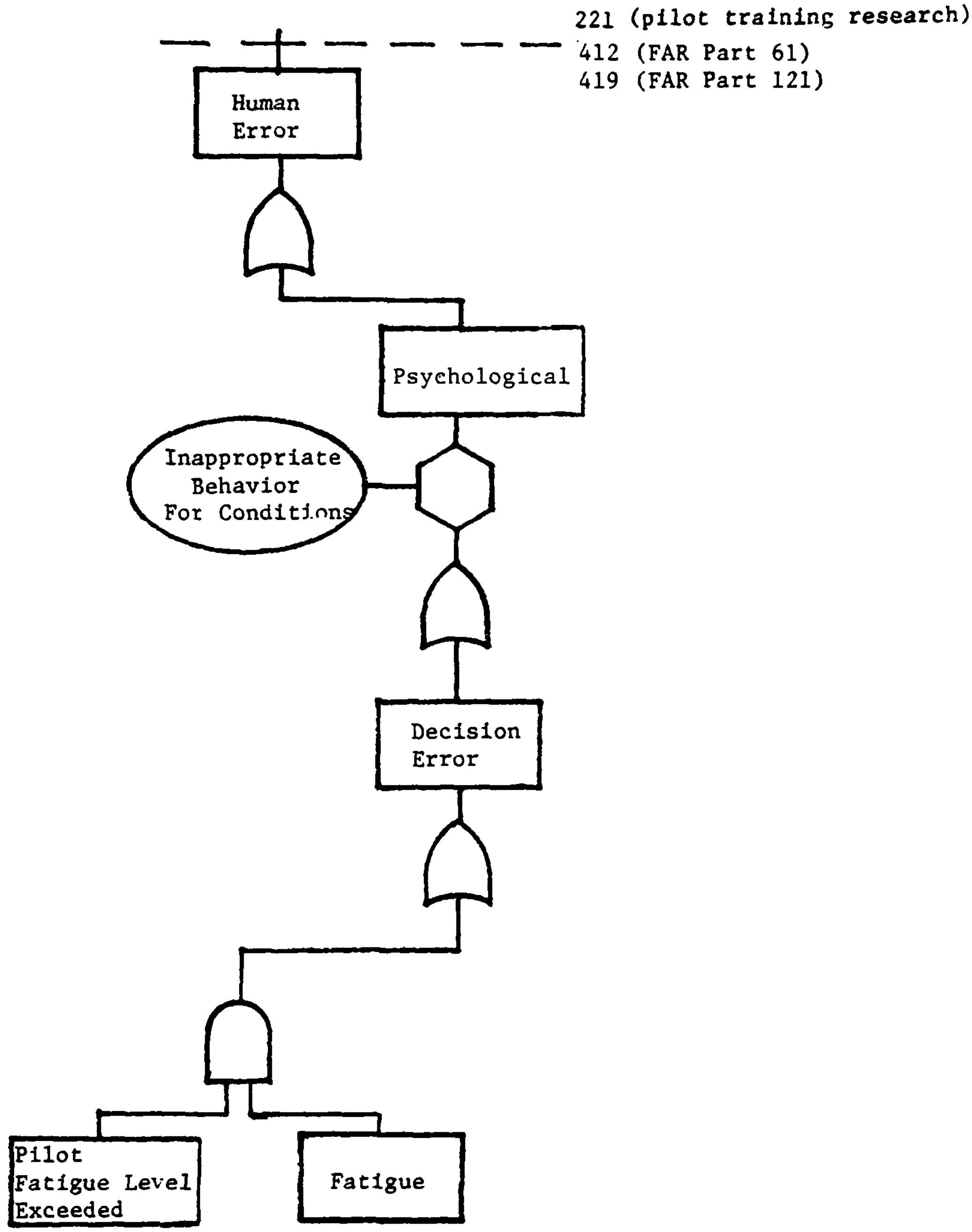


FIGURE 3-12. PARTIAL HUMAN ERROR CAUSE FAULT TREE: HIERARCHICAL LEVEL OF SAFETY PROGRAM INTERACTION

It is seen from the foregoing that by using the fault tree logic structure, it is possible to explicitly define accident data needs, and how these can be used in establishing an interlocking combination of programs directly aligned with causes at several hierarchial levels. All current FAA programs related to human cause (Figure 3-15) are general in their objectives and, accordingly, appear to implicitly treat causes at the higher levels in the fault tree. This generality applies to the facilities/equipment safety programs (Table 2-9) as well as those cited above. While other lower level safety programs may exist in Government or industry, there is little evidence of their explicit coordination with these cited FAA programs. Therefore, it is concluded that these existing programs, indirectly aligned at the top of the fault tree and apparently without more detailed supporting programs, are not significantly mitigating human causes in aircraft accidents.

70*99 (All Airframe Failures). The major cause/factor category 70*99 represents all airframe cause/factors that have been cited in the 13 year history (see Figure 3-4). This example was selected to show that the aggregation of certain mechanical failures is possible, while maintaining effective safety program alignment. In this case "landing gear failure" is the predominant mechanical failure in the airframe category, representing 97 out of 125 citations in the air carrier accident records. The individual cause/factor summaries of these landing failures are given in Figures B-23 through B-30 of Appendix B.

The low rates of occurrence of these failures indicates the problem is persistent, but not severe. There are no directly aligned safety programs associated with any of these mechanical failures. There are, however, numerous indirect programs including:

a. 305 QASAR
b. 308 MAC
c. 402 FAR Part 21
d. 404 FAR Part 25
e. 406 FAR Part 29
f. 409 FAR Part 37
g. 411 FAR Part 43

The low rate of occurrence of this cause/factor (only seven percent of all citations over the 13 years) indicates that these indirectly aligned programs are effectively mitigating this accident cause category. This point is

strengthened further by the fact that the landing gear is continually subjected to significant shock stresses during the life of the aircraft. An insight as to why these programs appear to be effective is depicted in Figure 3-13. The mechanical failure cause indicates design failure which, in turn, stems from several possible lower level causes. The programs indirectly aligned with these cause/factors are not specifically designed for landing gear failure, but, rather, for more general categories such as standards, certification, and monitoring. It is apparent that these are reactive safety programs aimed at detecting hazards or mechanical failures based on observed events, and at implementing corrective actions to prevent further occurrences. Their mitigation effectiveness (and, hence, the value of an integrated set of indirectly aligned programs) is supported by the sudden increases and decreases over time of the individual landing gear cause/factor time series (Figures B-24 through B-30).

To further reduce gear failures, more specific programs addressing causes at lower levels in the event chain would probably be necessary. However, such programs should not be implemented without consideration of other possible causes. One note of caution should accompany the above conclusion. The apparently random low frequency of occurrence of these gear failures suggests possible extenuating causes. For example, a pilot who continually has hard landings would eventually overstress the gear. If this fact were not known by an accident investigator, the cause, pilot error, would not be recorded along with the cause, landing gear failure. In this eventuality, regardless of the detail of a safety standards program, further mitigation of accidents may not be achieved; hence, the standards program would be ineffective.

The possibility of extenuating cause leads to the premise that certain cause/factor combinations might be occurring together to cause a particular type of accident. To examine this possibility, accident types were listed by cause/factor. These data are given in Appendix C for all 48 cause/factors used in this study. For the case of interest here, 57 hard landings were attributed to pilot error (pages C-1 to C-8), and 33 accidents were attributed to hard landings (see row G on page A-9). Relating these statistics to the fact that there were 50 gear collapsed accidents (see row E, page A-9) suggests that pilot error could be contributing to landing gear failures. With this information, a somewhat clearer understanding of the real impact of landing gear failure (70*C) is obtained as a basis for safety

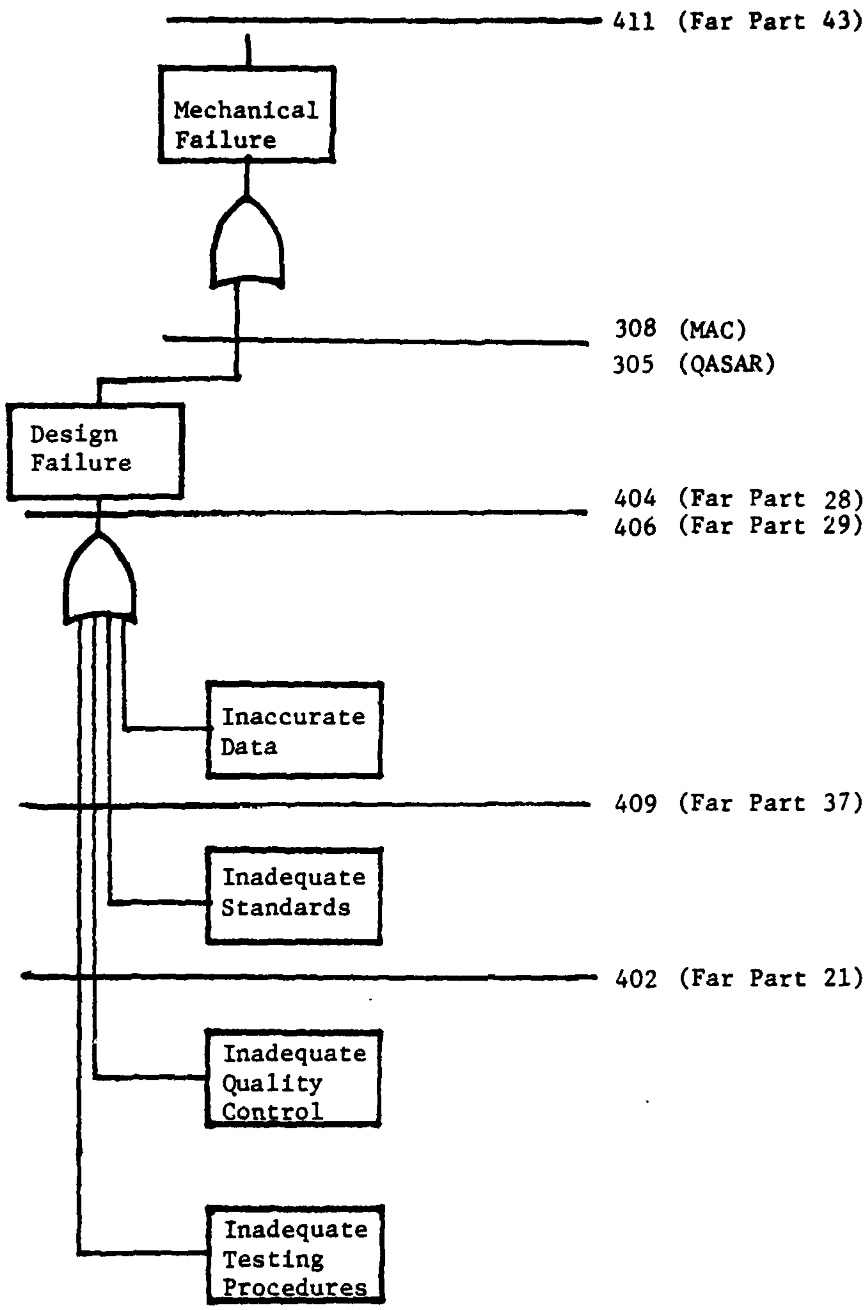


FIGURE 3-13. PARTIAL MECHANICAL FAILURE CAUSE FAULT TREE: LEVEL OF SAFETY PROGRAM INTERACTION

program development to combat it. That is, the total number pilot error hard landings (47) may exceed the total of hard landing accidents (33) because the former may have resulted in another accident type (under NTSB coding procedures) such as gear collapsed or collision with ground (see row MO on page A-9) While such a conclusion is speculative, being based on limited available data, it does illustrate the need to evaluate program combinations with respect to possible cause/factor interactions.

82*L (Turbulence Associated with Clouds/Thunderstorms). The cause/factor 82*L provides a third perspective in evaluating safety programs. The impact of this cause/factor on safety is shown in Figure B-44 of Appendix B. Its rate of occurence remains significant over the entire 13 year history, and accounts for 50 percent of all weather related citations and 6 percent of the total cause/factor citations. While this frequency is high, the impact on deaths and economic loss appears less significant. Cause/factor 82*L accounts for less than 2 percent of the total accident dollar loss and is associated with 8 percent of deaths. In comparison, the major cause/factor category 82*99 (all weather) accounts for 14 percent of total dollar loss and is associated with 77 percent of deaths.

Cause/factor 82*L has one directly aligned program--301 (Detecting/Sensing/Tracking Hazardous Weather). There are four indirectly aligned programs: 203, 225, 416, and 419. A partial cause/effect chain of weather accident event showing the hierarchial alignment of these programs is shown in Figure 3-14. The safety programs aligned against this cause/factor appear to be well-situated in the fault tree. The safety program 301 entails weather information gathering and monitoring systems designed to keep the system operators aware of environmental conditions (Programs 203 and 225 are R & D efforts). Further, there are several other established weather data sources such as reporting stations, long-range forecasts, and pilot reports that are also used by the system operators.

Given these apparently well-aligned programs, why is this cause/factor recurring, seemingly at a rate unrelated to the increasing technical improvements being made in the system? The answer is keyed to the conditional gate located in the event chain. For the "first cause" to have occurred, it is necessary to make a decision to operate in these hazardous conditions. Safety programs 416 and 419 are regulations which establish, among other things, the weather conditions under which an air carrier aircraft can conduct its operations. The regulations

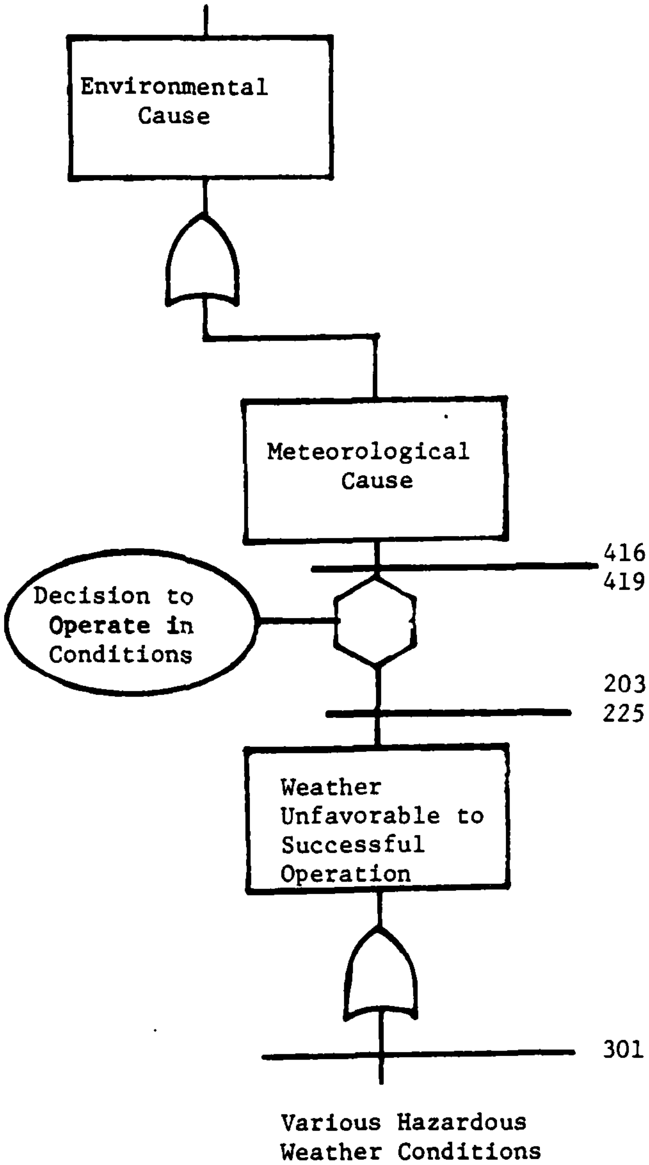


FIGURE 3-14. PARTIAL ENVIRONMENTAL CAUSE FAULT TREE: LEVEL OF SAFETY PROGRAM INTERACTION

removed from the 82*L summary data, a reduction of approximately 65 percent would result. The resulting statistics would provide a more precise picture of 82*L's impact on the accident record, that picture being one of low frequency of occurrence with correspondingly good safety program alignment and interaction. This finding, however, should not be construed to mean that less emphasis on enforcement is called for. Even though the percentage of accidents is low for 82*L when compared to other major accident causes, there are still too many fatalities and injuries associated with this cause/factor considering that an aircraft crash is rarely involved.

Safety Program and Accident Clusters. Using the combinational approach illustrated in the preceding cause/factor case evaluations, the safety programs considered in this study were classified with respect to their approach to accident prevention and aligned in related clusters in the accident cause fault trees described in Chapter 2.0. The results of the approach to accident prevention are shown in Table 3-17. The program and cause/factor cluster alignments are shown in Figures 3-14 through 3-16 and Tables 3-18 through 3-20.

TABLE 3-17. CLASSIFICATION OF SAFETY PROGRAMS BY ACCIDENT PREVENTION APPROACH

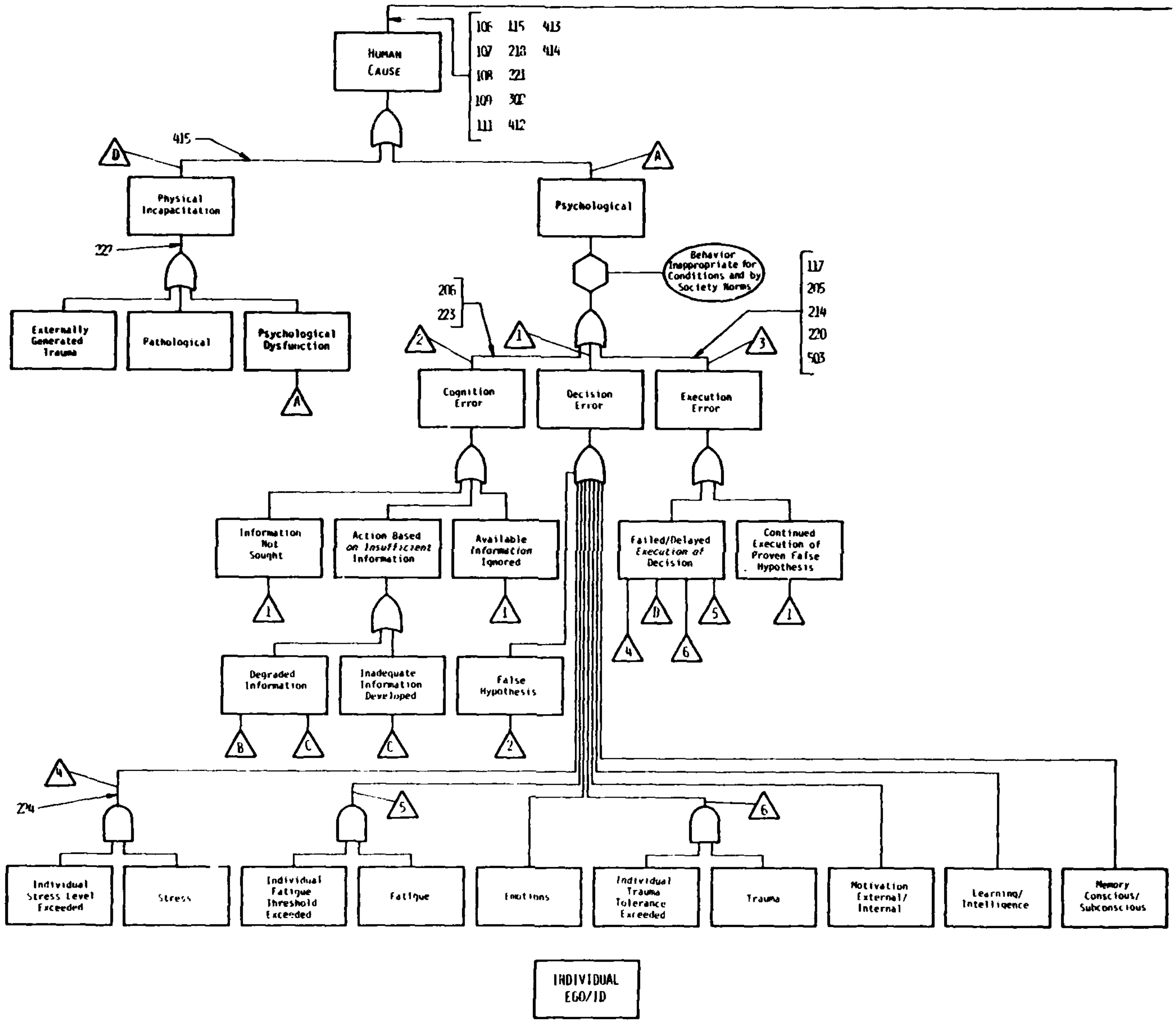
Operator Assisting	Monitoring	Remedial	Safety Standards
102	201	110	221
103	202	117	302
105	203	207	307
106	204	208	312
107	206	209	All 400's
108	215	210	501
109	216	211	507
111	217	212	601
112	219	213	602
113	225	218	604
114	301	222	605
115	305	223	606
116	306	224	607
205	308	303	
214	309		
220	310		
503	311		
504	313		
505	502		

consider the pilot capabilities, instrument equipment, the strengths of the airplane, and the severity of the weather in establishing safe standards of operation. Assuming that these standards have evolved from experience into safe guidelines, the decisions to operate in hazardous conditions outside of this level of system (government and airline management) control are left with the pilot. A decision to continue a flight, change course or abort ultimately is made by the pilot. The possible reasons for his decision are many, and only the pilot himself can explain why a particular action was taken.

In order to examine some observed human decisions in regard to the cause/factor 82*L, its frequency of citation was compared with that of the human error cause/factors 64*01, 68*KA, 68*R and 68*RO in all turbulence type accidents (see item Z on page A-9). For example, the cause/factor 64*01 was cited in conjunction with 82*L in 28 of 187 cases (15 percent). This fact means that NTSB accident investigators believed that in approximately 15 percent of the turbulence cases, the pilots (not weather conditions) were responsible for the accident. These implied failures included situations where the pilot failed to turn on the seat belt warning sign, failed to ensure compliance with such a warning, was inattentive to weather conditions, or failed to follow some approved procedure.

A second area of concern related to turbulence accidents was the high number of citations of the cause/factor 68*K4 (Passenger) with 82*L. Cause/factor 68*K4 is used by the NTSB when a passenger is deemed responsible for his own actions or inactions resulting in an accident or injury. Cause/factor 68*K4 was cited 54 times in connnection with turbulence accidents (page C-18); that is, passenger actions or inactions were responsible for 54 of the 187 (29 percent) turbulence accidents. These statistics suggest a lack of enforcement of the FAR's governing cabin safety and the airline procedures governing seat belt usage in flight. This lack of enforcement is supported by the NTSB citation of cause/factors 68*R and 68*RO (both causes involve flight attendants) in 38 of the turbulence cases (pages C-21 and C-22). These citations are used when investigators have determined that the attendants failed in their responsibility to ensure compliance with cabin rules.

The examples above illustrate how a cause/factor such as 82*L (Turbulence Associated with Clouds/Thunderstorms) can be misused. If all accidents involving the human-error cause/factor combinations described above were

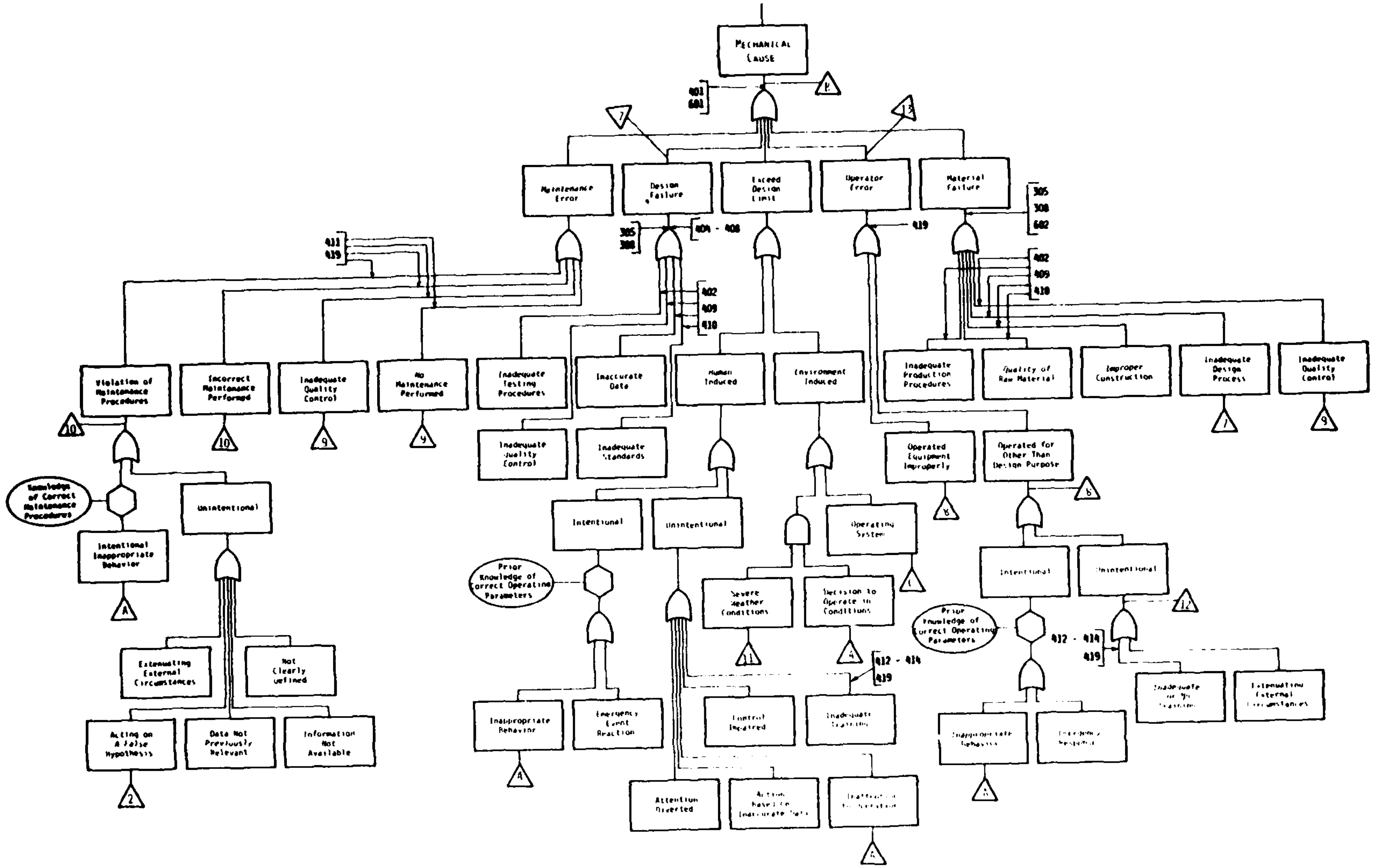


Note: Three digit program codes are described on pages 2-30 to 2-34.

FIGURE 3-15. HIERARCHICAL ALIGNMENT OF FAA SAFETY PROGRAMS IN THE HUMAN CAUSE FAULT TREE

TABLE 3-18. SAFETY PROGRAM EVALUATION SUMMARY: HUMAN FACTOR ACCIDENT CAUSES

Accident Cause Fault Tree		Safety Programs		Cause/Factor Alignment	
Description	Level	Code	Approach	Direct	Indirect
Human Cause	I	106	Operator Assistance	--	64*02
	"	107	"	--	64*02
	"	108	"	--	64*02
	"	109	"	--	64*02
	"	111	"	--	64*02
	"	115	"	--	64*02, 80*00
	"	218	Remedial	64*02	--
	"	221	Safety Standards	--	64*01, 64*02
	"	302	"	--	64*01
	"	412	"	--	64*01
	"	413	"	--	68*00
	"	414	"	--	68*00
Physical Incapacitation	II	415	Safety Standards	64*04	68*00
	"	222	Remedial	--	--
Cognition Error	II	206	Monitoring	84*7	64*03, 68*KO
	"	223	Remedial	--	64*03, 68*KO
Execution Error	II	117	Remedial	80*BA	--
	"	205	Operator Assistance	--	64*02
	"	214	"	--	64*02
	"	220	"	--	64*02
	"	503	"	--	--
Stress	III	224	Remedial	--	68*00, 68*69

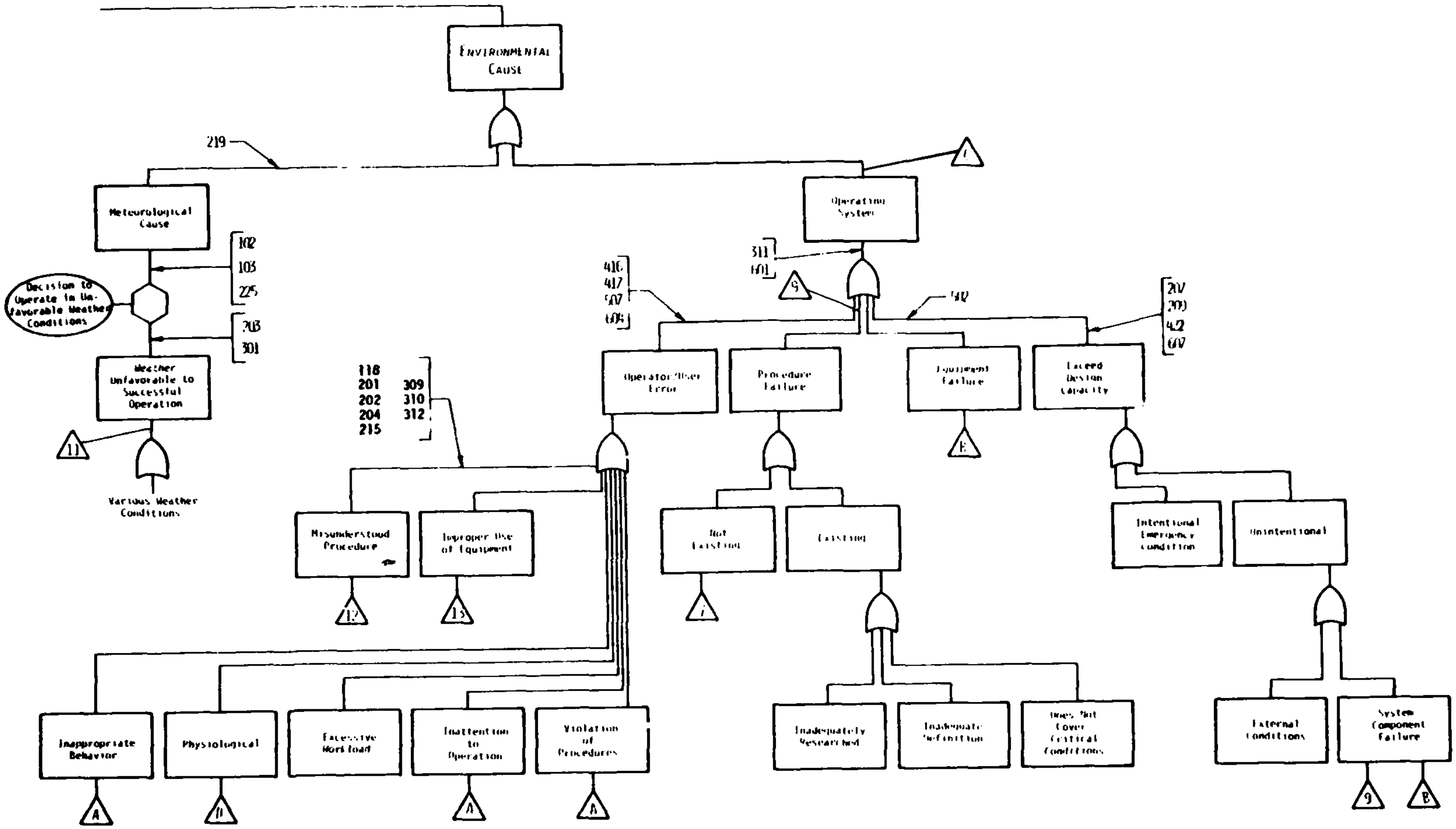


Note: Three digit program codes are described on pages 2-30 to 2-34

FIGURE 3-16. HIERCHICAL ALIGNMENT OF FAA SAFETY PROGRAMS IN THE MECHANICAL CAUSE FAULT TREE

TABLE 3-19. SAFETY PROGRAM EVALUATION SUMMARY: MECHANICAL ACCIDENT CAUSES

Accident Cause Fault Tree		Safety Programs		Cause/Factor Alignment	
Description	Level	Code	Approach	Direct	Indirect
Mechanical Cause	I	401	Safety Standards	--	68*K4, 68*R, 68*RO
	"	601	Safety Standards	--	68*00
Maintenance Error	II	411	Safety Standards	68*DO, 68*D4, 68*D6	68*00, 79*00, 74*00, 75*00, 76*00, 78*00
	"	419	Safety Standards	--	68*00, 68*D4, 68*D6, 68*K1, 68*K3, 68*R 68*RO, 82*X
Design Failure	II	305	Monitoring	68*J0	70*00, 70*CA, CB, CC, CE, CF, CJ, CM
	"	308	Monitoring	--	74*00, 75*00, 76*00, 78*00, 68*J0 (308 only)
	II	404	Safety Standards	--	70*00
	"	405	"	--	78*00
	"	406	"	--	70*CA, CB, CC, CE, CF, CJ, CH, 75*BD
	"	407	"	--	74*00, 74*AD, 74*ME
	"	408	"	--	74*00
	"	402	"	--	68*00, 70*00, 70*CA, CB, CC,CE,CF,CJ,CM,
	"	409	"	--	74*00, 75*00, 75*BD, 76*00, 78*00
	"	410	"	--	70*00, 74*00, 75*00, 76*00, 78*00
Inadequate Training	V	412	Safety Standards	--	64*01
	"	413	"	--	68*00
	"	414	"	--	68*00
		419	"	--	68*00, 68*D4, 68*D6, 68*K1, 68*K3 68*R, 68*RO, 82*X
Operator Error	II	419	Safety Standards	(See program code 419 above)	
Material Failure	II	305	Monitoring	(See program code 305 above)	
	"	308	Monitoring	(See program code 308 above)	
	"	602	Safety Standards		68*J0
	"	402	"	(See program code 402 above)	
	"	409	"	(See program code 409 above)	
	"	410	"	(See program code 410 above)	



Note: Three digit program codes are described on pages 2-30 to 2-34.

FIGURE 3-17. HIERACHICAL ALIGNMENT OF FAA SAFETY PROGRAMS IN THE ENVIRONMENTAL CAUSE FAULT TREE

TABLE 3-20. SAFETY PROGRAM EVAULATION SUMMARY: ENVIRONMENTAL ACCIDENT CAUSES

Accident Cause Fault Tree		Safety Programs		Cause/Factor Alignment	
Description	Level	Code	Approach	Direct	Indirect
Meteorological Cause	II	219	Monitoring	82*00	--
		102	Operator Assistance	--	68*00, 82*00, 82*H
		103	Operator Assistance	--	68*00, 82*00, 82*H
		225	Monitoring	--	82*00, 82*L
		203	"	--	82*00, 82*L
		301	"	82*X	82*GJ
Operating System	II	310	Monitoring	--	68*00, 80*00
		601	Safety Standards	--	68*00
Operator/User Error	III	416	Safety Standards	--	82*L
		147	"	--	--
		507	"	--	--
		604	"	--	--
Misunderstood Procedure	IV	201	Monitoring	--	84*7
		202	"	84*7	64*03
		204	"	--	68*KO
		215	"	--	--
		118	"	--	--
		309	"	64*03	--
		311	Safety Standards	--	68*00
		312	Monitoring	--	68*00, 68*G9
Exceed Design Capacity	III	207	Remedial	--	82*00
		209	Remedial	80*00	--
		422	Safety Standards	--	68*00, 80*00, 80*BA, 84*00
		607	Safety Standards	--	68*00

Examination of these cluster alignments reveals several general patterns that portray the balance and collective effectiveness of the safety programs in the three major accident cause areas

a. Mechanical safety programs appear evenly distributed at fairly high accident cause levels

b. Human error programs are clustered in tight groups at the highest levels of the fault tree

c. Environmental related safety programs reveal a combined pattern of the other two program areas. These programs tended to be clustered, like human error programs, but at the same relative level in the fault tree as mechanical programs.

Interpretations of these patterns with respect to program effectiveness in three respective areas are given in the following paragraphs.

The high level cluster pattern associated with programs in the mechanical categories can best be explained in terms of technological migration over time. To substantiate this explanation required a greater historical perspective of mechanical program evolution than covered in this study. Taking this longer perspective, the logic of the technological migration pattern appears evident. Specifically, in the early periods of the air carrier industry's development, mechanical safety programs were specific in nature and limited in scope. For example, the problems of powerplant operating reliability were dealt with discretely at the component level. As these component problems were solved (with the concommitant cause/factors mitigated in their severity) and technological information was accumulated, broader scope programs evolved,eventually culminating in the adoption of general standards which provided the necessary controls to assure safety. Such standards deal with a broad spectrum of powerplant programs and no longer need to explicitly address each individual cause/factor. These higher level programs (airworthiness standards, etc.) now have been integrated into a comprehensive network of mechanical design, manufacturing and operating standards. The principal element in this process (and still serving to further perfect mechanical systems) is the accumulation of research and product development information; i.e., technological innovations. This work being performed by all segments of the air carrier industry through a common commitment, has significantly reduced

the number of accidents related to mechanical causes.

The clusters shown in Figure 3-15 and Table 3-18 concerning human error related safety programs are mainly a result of program definitions based on "what happened" (symptoms) versus "why it happened" (behavioral explanations) typical of accident investigations involving this cause/factor category. Mainly, these programs constitute a range of mechanical substitutions or aids in dealing with problems of human control. To date, the nature of this mechanical (psuedo-human) approach to human error (mainly pilot/controller error) is typically manifested in two ways. First, mechanical systems are designed that diminish (or eliminate) the human input in controlling a specific operation (for example, coupled ILS approach). Second, systems are designed that assist pilots in the normal operation of their duties (for example, GPWS or potential collision alert). This second approach also tends to influence and increase the minimum standards (in quantative and qualitative terms) required to become and remain a pilot/controller in the aviation system, because the pilot/controller is required to integrate an increasing number of machines in his operating environment. Both of these specific approaches circumscribe the development of a narrow range of programs to address a broad spectrum of human error cause/factors. It is important to note, however, that these approaches have had a significant positive safety impact. This impact has been most visible through realization of a high level of productivity both with respect to personnel and equipment utilization while maintaining a relatively low overall occurrence rate for accidents. Nonetheless, the expected effectiveness of these programs in further reducing human error accidents appears to be limited. The reason for these restrictions is discussed below.

The clustering of human error safety programs at high accident level cause is inappropriate given the present state of knowledge. The salient finding is that these programs are general, dealing with human error at the uppermost accident cause level; but, in contrast to analogous mechanical programs, do not embody accumulation of technical knowledge. Lacking evolutionary accumulations of knowledge concerning the behavioral nature of human error, these safety programs cannot be specific as to actions necessary to combat their causes. Moreover, lacking this basic understanding, it is not possible to integrate human error, system tolerance, and environmental programs, with respect to how the overall system is affected by propagation and/or amplification of corresponding cause/effect errors.

It follows, as noted before, that this treatment of human error causes of accidents is thus limited to symptomatic problems.

Thus, the human error related safety programs generally depict an attempt to create mechanical systems that mitigate the effects of human error while expanding the system's tolerances for breakdown at the man-machine interface. Because there is a serious void of basic information concerning human behavior, the continued growth of programs in this area will likely have little positive impact on accident prevention. Recent accidents have revealed that these mechanical (pseudo human) error related programs might even be having a negative impact on safety stemming from possible overloads of the man-machine interfaces in spatial and temporal environments resulting in the misuse, misunderstanding or disregard of mechanical aids.

The environmentally related safety programs embody mechanical and human program characteristics. The alignment of environmental programs in the fault tree shown in Figure 3-17 reveals several clusters (as in the case of human error programs, but at lower hierarchial accident cause levels as in the case of mechanical programs). These clusters generally reflect technological proficiency in collecting, processing and disseminating environmental data (for example, weather data gathering); but suggest a lack of understanding concerning timely and systematic use of the data required for effective human control in hazardous environmental conditions. Thus, safety program effectiveness in this area is found to be mixed. It is apparent that improvements in this program area require a systematic determination of the relationships between information needs and the operating environment; especially in light of the high frequency of joint citation of human error and weather cause/factors in the accident records.

SUMMARY OF ANALYSIS AND EVALUATION RESULTS

In judging FAA safety programs as described in the preceding sections of this chapter, two qualifications should be noted. First, this project is based on an empirical study of accident records. These data are of limited value in evaluating safety programs that are directed solely at theoretical safety hazards; i.e. hazards for which there are no associated accidents. Second, while the analyses and evaluations have revealed safety voids suggesting programmatic initiatives, decisions to terminate programs cannot be justified solely on the results of this empirical study.

A decision to end a particular safety program should be made only when based on a more comprehensive conceptual understanding of the program's relationship to total systems safety.

With the foregoing cautions, the evaluation findings are listed below and discussed individually in the following paragraphs:

a. Safety Program Alignment

b. Successful Individual Programs

c. Safety Programs-Mechanical

d. Safety Programs-Weather

e. Safety Programs-System

f. Safety Programs-Human Error.

Safety Program Alignment

The majority of FAA safety programs is indirectly aligned with accident cause/factors. These alignments stem from the fact that specific cause/factors were not directly cited in the stated safety objectives of the programs. Two explanations were found in the evaluation process. First, the 547 individual cause/factors frequently represent a too detailed level of disaggregation for program alignment. Second, explanatory, as opposed to descriptive causes of the accidents are not, in general, cited in many investigations. Cases exemplary of both explanations were found in the accident records. Mechanical failures tend to be highly disaggregated, typically involving citation of component failure and the physical nature of such failures. On the other hand, human error cause/factor citations tend to be non-specific as to the cause of the error.

Successful Individual Programs

A profile of a successful safety program includes the following characteristics:

a. The program addresses a specific well-defined safety hazard

b. The program explicitly treats all cause/factors (and their interrelationships) contained in the hazard definition.

c. Program interaction with complementary programs is explicitly coordinated in terms of approach to accident prevention and alignment in its associated accident cause hierarchy.

d. The program receives timely data feedback from the incident/accident reporting system and uses these data to maximize its continuing effectiveness in terms of accident prevention.

These characteristics are present in varying combinations in virtually all successful safety programs. However, it has been established in this profile that it is the balance among the characteristics that makes the difference between successful and unsuccessful programs. An example of an ineffective program is cockpit human factors research (218). This program satisfies the first characteristic of a successful profile, but fails the remaining three. An example of a successful program is FAR Part 21, Certification Procedures-Products and Parts (402). This program has specific objectives, deals directly with an identifiable cause level, is in a complete and supportive safety group in terms of both objectives and approaches, and receives positive, direct data feedback on its effectiveness in mitigating accidents. The impact of this program (and its allied group) was found to be significant in preventing accidents.

Safety Programs - Mechanical

There is an impressive array of safety programs aligned against mechanical causes of accidents. They appear to be largely responsible for the overall reduction of air carrier accidents. The typical mechanical safety program covers several specific cause/factors (typical of indirect alignments). These programs also focus on cause/factors at an effective accident prevention level. Additionally, this array of programs is tightly interwoven to provide effective cross program support. Lastly, and perhaps most important, these programs have an almost continuous data feedback loop with incident/accident reporting systems.

The programs associated with this accident prevention success are principally aligned in the second and third levels of the mechanical cause hierarchy.

Collectively, they form an intricate system of standards, certification, active and passive monitoring programs, and rapid remedial responses to hazards detected in the aviation environment. These are essentially the "nuts and bolts" programs (e.g., FAR's QASAR, MAC, etc.) that deal directly with specific failures.

Safety Programs - Weather

Safety programs associated with the weather cause/factors are technically and operationally well-aligned. They satisy the attributes of successful programs. Yet, weather cause/factors are still cited with high frequency in accident investigations. It is the finding of this study that this observed lack of effectiveness in accident prevention stems from unresolved joint effects of weather and pilot error cause/factors.

Weather cause/factors in the accident record citations are used for two purposes. First, they are cited appropriately as the first cause of an accident. Second, weather cause/factors are used as qualifying citations in an accident cause/event chain. The magnitude of this latter usage is evident in the statistic that only five of 800 accidents were entirely the result of weather causes. It is important to note that this finding does not imply that weather cause/factors are insignificant. On the contrary, weather cause/factors complicate almost every cause/effect chain in which they are cited. Hazardous weather increases the probability of an accident, especially in conjunction with other system failures (e.g., an engine failure in flight or pilot error/cognition).

An apparent anomaly associated with this finding is that the safety programs aligned with this hazard are effective. The forecasting, analyzing, detection, and weather reporting components are available on demand for air carriers. The regulations and procedures (both Government and air carrier) that have been established for operating in this weather environment are based on experience and are designed to permit the maximum level of safe weather operations. The resolution of this anomaly lies in the cause/factor combination pilot error and weather. The cause/effect relationship between these cause/factors and its associations with system tolerances do not appear to be well-understood.

The major areas for improvement in this category of programs include the means for more timely communications and use of pertinent weather data and review of external pressures and procedures influencing pilot behavior under weather-related critical conditions.

Safety Programs-System

System safety programs deal mainly with developing mechanical and procedural tolerances for human error in the aviation system. These programs mainly include operator assistance and safety standards programs. The objectives of these programs are two-fold: establish a minimum safety level in the aviation system, and assist system operators in maintaining this safety level. Operator assistance mainly consists of mechanical systems (e.g., ILS's, VASI, DME's, etc.). Safety standards establish a regulatory base which provides an expanded spatial and temporal margin within which a pilot/controller/mechanical error can be committed and then rectified without resulting in an accident.

These programs are generally well-aligned and are distributed against their associated cause/factors. However, the accident data portray a low but persistent rate of occurrence of these accident cause/factors.

The predominant causes of system related accidents involving human links to mechanical tolerances are: operator/user error and procedure failure. These errors occur in accidents where all the mechanical equipment is functioning, all procedures and regulations are being followed and the weather is not a factor. Such accidents are the consequence of apparently insignificant mistakes made by system operators (pilot/crew/air traffic control). It is a finding of this study that these accidents stem from the design and use of mechanical systems that have not considered the human tolerances for the introduction of the system. The finding is amplified by evidence suggesting that several recent accidents are associated with operator/user dependence on a system. These relationships, however, are not fully understood. This lack of knowledge concerning this human interaction weakens the vital safety links between mechanical systems, procedures, and performance. Thus, while these system programs are generally effective in accident prevention, greater attention should be directed to investigating these system-wide relationships.

Safety Programs-Human Error

There are few safety programs even indirectly related to preventing the human error causes of accidents. The programs that are aligned with this cause/factor category are essentially mechanical in nature. They generally seek solutions that address human error in two ways

a. As a mechanical system designed as a replacement for pilot control of an aircraft

b. As a mechanical system designed to assist the pilot/controller in preventing decision/execution/cognition errors. The programs generally found associated with this area are operational and research programs designed to replace, monitor or alert the pilot/controller to potential hazards (e.g., Ground Proximity Warning Systems, Minimum Safe Altitude Warning, Conflict Alert, etc.).

The principal finding of this study regarding this program category is that in spite of well-written procedures, intensive training, sophisticated systems, and constant operational monitoring, human errors are increasingly dominant in accident citations. In the 1975-1976 data investigated in this study, human error cause/factors were cited in 83 percent of all accidents compared to 68 percent for the entire 13 year study period. While safety programs in this category include operator assistance, and monitoring remedial and safety standard programs, there is no evidence of an integrating logical structure. That is, these programs generally do not encompass the successful program attributes cited earlier in this section. This is particularly true in the case of data feedback. Specifically, lack of human factors behavioral data has resulted in programs that treat the symptoms, but not the causes of human error.

These findings further corroborate those of prior research based on air carrier accident investigations to identify patterns or "hidden causes" of accidents. The conclusions of a study by the Lovelace Foundation, June, 1974, for NASA, An Analysis of Pilot Error Related Aircraft Accidents, stated in part

a. "Human factors data as currently collected are inadequate in defining the "why" of pilot error and the terminology and classification gives no insight into corrective measures."

b. "A number of areas have been identified that require more research.

These include such items as crew inter-relationships (coordination, interaction), decision-making, approach monitoring, aircrew fatigue (work/rest schedules), and subtle operational indices of crew stress and performance decrement. Current airline pilot training does not seem to adequately prepare the pilot for the situations encountered in the critical elements identified in this study. Furthermore, details of cockpit activity and events are not known in sufficient detail; cockpit voice recorder data do not provide needed information."

c. "There is a need for intensive study into the relationships that exist between pilot, airlines, and regulatory bodies, with special attention to defining and understanding how institutional decisions which involve all of these groups interact to affect flight safety."

d. "Airline training and operational procedures must be updated to improve the reliability of the pilot as an information processor."

e. "There is a need for improvement in accident investigation, to include

(a) More systematic collection of human factors data at the accident site
(b) There is a need for more information to reconstruct what transpired in the cockpit prior to the accident
(c) Reliability of information must be improved by reassessing pertinent rules and principles of legal liability
(d) There is a need for developing an on-site system to allow quick determination of the likelihood that a given accident has prominent human factors aspects. This could lead to a more intensive investigation of human factors features on site, when the information is still fresh."

f. "More attention should be focused on the human error aspects of near-accidents and incidents."

A second study, A Method for the Study of Human Factors in Aircraft Operations, published by the NASA Ames Research Center in September, 1975 stated

"It has long been recognized by aviation safety workers that the attribution of an accident or incident to "pilot error" leaves unanswered

the question of why the error was committed. Yet attempts to answer this most difficult question have often been thwarted by a lack of evidence, especially in fatal accidents. The investigation of incidents has been somewhat more productive, but even here, problems related to legal liability and punitive measures have inhibited the free flow of information regarding the possible reasons why an error occurred. As a result, we do not have a clear understanding of the factors which cause even well-trained, professional pilots to become involved in errors at critical points in flight. Neither do we understand, except in isolated cases, the factors which may be responsible for their failure to recognize and react to presumably clear warnings, or to intervene under circumstances which seem to clearly require such intervention. We lack, in short, understanding of the microstructure of human behavior in the aviation environment, and thus an understanding of the causes of human errors in that environment."

Finally, in the paper, The Reporting of Human Factors Information in Aircraft Accidents (1971), presented by Mr. James Danaher (then) Chief, Human Factors Branch, Bureau of Aviation Safety, NTSB, to the Second Annual Seminar of the Society of Air Safety Investigators, the limited success in this area was stated as follows:

"One explanation for the limited success in preventing efforts in these areas is that we are not obtaining the right kind of information to identify the most needed prevention efforts.

As investigators, most of us would readily admit that collecting evidence on the human involvement in an accident is much more difficult than obtaining information on the nature of an engine malfunction or structural failure. Additionally, with the physical wreckage, an experienced investigator can calculate or infer the nature or sequence of an accident situation. But human behavior is not amenable to that sort of precision.

Further, human factors data are missing in both the area of cause determination and in the area of crash-injury information. With regard to accident cause, too often our statements tend to be

objective summaries of what happened rather than statements of the true underlying cause of the accident. In the case of crash-injury, we are simply lacking specific details concerning impact dynamics, occupant restraint effectiveness, and related matters upon which to evaluate the human involvement."

CHAPTER 4.0 FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to evaluate the effectiveness of FAA safety programs with respect to the causes of air carrier accidents. Accomplishment of this objective entailed adaptation of the NTSB accident cause/factor data base for program evaluation purposes, alignment of cause/factors and programs, and evaluation of programs based on the consequent alignments. The findings, conclusions and recommendations presented in this chapter cover these elements of the subject study.

FINDINGS

The study findings described in the following paragraphs concern

a. Accident investigation data
b. Air carrier accident history
c. Safety program alignment
d. Successful safety program profile
e. Mechanical safety programs
f. Environmental safety programs
g. Human error safety programs.

Accident Investigation Data

The NTSB accident investigation data base required modification for purposes of safety program analysis and evaluation. The most important data base modifications were required in the area of human error (pilot/crew/other personnel) accident cause/factors. The NTSB human error cause/factors given in the Manual of Code Classification characterize what happened in an accident; but do not explain why it happened. To provide a better basis for program evaluation, three human error cause/factor substitutes were defined which corresponded to pilot/crew behavior. These substitute human error codes are decision, execution and cognition. A second adjustment was required to compensate for the common use of some cause/factors as supplemental information. That is, an accident record frequently includes cause/factor citations that are

used only to qualify other codes cited as causes or factors. These qualifiers further describe circumstances involved in an accident, but are not causes themselves. These qualifiers (codes 83 and 88) were deleted from the data base records used in this analysis. An example of such an accident coding from the air carrier file illustrating the above problems in using the NTSB accident data entails the citations

64C20, 64C50, 64C22, 75LAL, 80LBA, 88K94, 88LCI

where the codes are identified in the MCC as follows:

64C20 - Pilot failed to follow approved procedures, directives, etc....
64C50 - Pilot misjudged speed
64C22 - Pilot improper operation of brakes
75LAL - Electrical system switches
80LBA - Wet Runway
88K94 - Overload Failure
88LCI - Overheated.

The investigator's comments also recorded in the file are, "Boost pump switches overheated. Crew mistook source of odor. Took wrong actions. Landed too fast for runway conditions." The flight crew detected an odor after departure and began standard isolation procedures of the electrical system to determine the source. After identifying the suspected electrical buss, but not the exact source or the problem, the power was restored to the system with no further odor being detected until about 30 minutes before landing. The odor became strong again during preparation for landing. This recurrence of the problem appeared to bother the flight captain. He requested that the buss be turned off for landing. The copilot recognized that the anti-skid system for the brakes was also on this electrical buss. He informed the captain and suggested that power be restored just prior to touchdown to permit the system's use because it had been raining and the runway was reported wet. No recognition or response from the captain could be determined as a result of this statement, and the copilot and engineer did not repeat the warning. The weather was reported VFR, although it had been raining prior to landing. The aircraft landed at a speed considerably above published landing speeds. In the ensuing braking and reverse thrust actions,

the captain finally activated the emergency braking system, which, without the anti-skid system, caused the aircraft to veer off the runway.

What were the causes and factors of this accident, the pilot's decisions, the copilot's inactions, the engineer's silence or the mechanical failure? This accident certainly deserved more investigative attention as to human error. It is recognized that an air carrier accident is an extremely complicated event and that a clear cause finding cannot be expected from every crash, but the multiple probable cause citations create ambiguities that mislead safety planners. While NTSB accident investigators are highly skilled and have achieved remarkably unambiguous results in detecting mechanical failures, this clarity is not equalled in the human area. As in the above accident citation, investigators have stopped short of determining _why_ the pilot failed to follow approved directives, procedures, etc... It simply is not good enough to let the failure rest at this level. What kind of safety program could deal with "pilot failed to follow, etc...."? Lacking explicit information better explaining human error in the accidents reviewed in this study, it was necessary to make inferences (in the context of the modified cause/factor codes) as a basis for identifying safety program needs.

Air Carrier Accident History

A precipitous decline in air carrier accidents occurred over the years from 1964 through 1970. This decline was due in large part to the reduction of mechanical failures of all types. A much slower, but still significant decline occurred over the years from 1971 through 1976 and was attributable to programs such as improved and more widely available ILS's, system automation (ARTS), higher safety standards (FAR's), and an increased safety awareness on the part of the air carrier industry.

The record of the air carrier industry in this latter period of declining accident rates reveals that very few aircraft accidents were due to catastrophic mechanical or environmental causes. In fact, it became apparent that human error was the dominant cause of these remaining accidents. Further, these errors were made in spite of elaborate mechanical systems designed to

assist or replace the pilot in the operation of the aircraft. Many accidents appear to be degenerative in nature; i.e., their causes involve combinations of human decision/execution/cognition errors compounded by mechanical and environmental (weather and operating system) factors.

Safety Program Alignment

The majority of FAA safety programs is indirectly aligned with accident cause/factors. These indirect alignments stem from the fact that specific cause/factors were not directly cited in the stated safety objectives of the programs. Two explanations were found in the evaluation process. First, the 547 individual cause/factors frequently represent too detailed a level of disaggregation for the program alignment. Second, explanatory, as opposed to descriptive, causes of the accidents are not, in general, cited in many investigations. Cases exemplary of both explanations were found in the accident records. Mechanical failures tend to be highly disaggregated, typically involving citation of component failure and the physical nature of such failures. On the other hand, human error cause/factor citations tend to be non-specific as to the cause of the error.

Successful Safety Program Profile

A profile of a successful safety program includes the following characteristics:

a. The program addresses a specific well-defined safety hazard.

b. The program explicitly treats all cause/factors (and their interrelationships) contained in the hazard definition.

c. Program interaction with complementary programs is explicitly coordinated in terms of approach to accident prevention and alignment in its associated accident cause hierarchy.

d. The program receives timely data feedback from the incident/accident reporting system and uses these data to maximize its continuing effectiveness in terms of accident prevention.

These characteristics are present in varying combinations in virtually all successful safety programs. However, it has been established in this profile that it is the balance among the characteristics that makes the difference between successful and unsuccessful programs.

Mechanical Safety Programs

The impressive array of safety programs aligned against mechanical causes of accidents appears to be largely responsible for the overall reduction of air carrier accidents. The typical mechanical safety program covers several specific cause/factors (typical of indirect alignments). These programs also focus on cause/factors at an effective accident prevention level. This array of programs is tightly interwoven to provide effective cross program support. Last, and perhaps the most important, these programs have an almost continuous data feedback loop with incident/accident reporting systems.

The programs associated with this accident prevention success are principally aligned with the second and third levels of the mechanical cause hierarchy. Collectively, they form an intricate system of standards, certification, active and passive monitoring programs, and rapid remedial responses to hazards detected in the aviation environment. These are essentially the "nuts and bolts" programs (e.g., FAR's, QASAR, MAC, etc.) that deal directly with specific failures.

Environmental Safety Programs

Safety programs associated with the weather cause/factors are technically and operationally well-aligned. They satisfy the attributes of successful programs. Yet, weather cause/factors are still cited with high frequency in accident investigations. It is the finding of this study that this observed lack of effectiveness in accident prevention stems from unresolved joint effects of weather and pilot error cause/factors.

Weather cause/factors in the accident record citations are used for two purposes. First, they are cited appropriately as the first cause of an accident. Second, weather cause/factors are used as qualifying citations in

an accident cause/event chain. The magnitude of this latter usage is evident in the statistic that only five of 800 accidents were entirely the result of weather causes. It is important to note that this finding does not imply that weather cause/factors are insignificant. On the contrary, weather cause/factors complicate almost every cause/effect chain in which they are cited. Hazardous weather increases the probability of an accident, especially in conjunction with other types of failures (e.g. an engine failure in flight or pilot error/cognition).

An apparent anomaly associated with this finding is that the safety programs aligned with this hazard are effective. The forecasting, analyzing, detecting and weather reporting components are available on demand for air carriers. The regulations and procedures (both Government and air carrier) that have been established for operating in this weather environment are based on experience and are designed to permit the maximum level of safe weather operations. The resolution of this anomaly lies in the cited cause/factor combination pilot error and weather. The cause/effect relationship between these cause/factors and its association with system tolerances do not appear to be well-understood.

The major areas for improvement in this category of programs include means for more timely communications and use of pertinent weather data , and review of external pressures and procedures influencing pilot behavior under weather related critical conditions.

Human Error Safety Programs

The principal finding of this study regarding human error programs is that in spite of well written procedures, intensive training, sophisticated systems, and constant operational monitoring, human errors are increasingly the cause of air carrier accidents. In the 1975-1976 data examined in this study, human error cause/factors were cited in 83 percent of all accidents compared to 68 percent for the entire 13-year study period. This trend is, in large part, traceable to the progress made in dealing with the mechanical problems during this time period. However, it also reflects the slower progress experienced in coming to grips with the human factor dimension of the problem. The safety programs in this area, while representing all four approaches to accident

prevention (see Table 3-17), appear to suffer from a lack of integrating program structure. In other words, they do not receive support (nor support each other in many cases) from the rest of the safety system programs. Additionally, these programs generally do not encompass many of the other successful program attributes cited earlier in this section. This is especially true where feedback is concerned. The lack of human factors behavioral data has resulted in programs that often treat the symptoms, but not the causes, of human error.

CONCLUSIONS

The conclusions stated in the following paragraphs concern safety gaps, program balance, and future needs in the three major accident cause/program areas

a. Mechanical safety programs
b. Environmental safety programs
c. Human error safety programs.

Mechanical Safety Program

It is concluded that no substantive change is required with respect to mechanical safety programs. These programs effectively mitigate associated hazards, are balanced with respect to their coverage of the major cause/factor categories and have evolved over time into cohesive program clusters that effectively embody accumulations of technological knowledge.

Environmental Safety Programs

A broader investigation into the integration of environmental programs with human factors programs is required if significant improvements in understanding weather cause/factor citations are to be achieved. Weather programs are balanced with respect to their coverage of cause/factors within this code classification category, are responsive to identified hazards and address problems at appropriate levels in the accident cause hierarchy. In these respects, environmental programs parallel mechanical programs. However, the high citation frequency rate of weather cause/factors in conjunction with human error

cause/factors suggests a lack of sufficient attention to the man-man, man-machine, and man-system interface. System level programs aimed at optimizing operations in specified temporal and spatial conditions are needed.

Human Error Programs

New program initiatives are required that address human error problems in behavioral terms at detailed cause/factor levels. Such detailed programmatic efforts are needed as a knowledge base for existing, broader, programs (monitoring, standards, etc.) to be effective. To achieve further reduction in the air carrier accident rate, attention must be focused on investigating the human error causes in all aspects of the aviation system. All human operators (pilot, crewmember, mechanic, air traffic controller, etc.) are now the leading cause of aircraft accidents. Their percentage of participation in all accidents has been steadily increasing over the study period. They are associated with at least 92 percent of deaths and 62 percent of total dollar loss in the last two years of the study.

The search for hidden causes (behavioral phenomena) in earlier research centered on investigating human errors in varying combinations of associations with mechanical or weather related factors. Further, they sought hidden causes for accidents that occurred despite elaborate technical systems designed to prevent them. While these attempts were well-defined, definitive results are still lacking. These hidden causes have been defined in this study to be intricate and subtle pressures applied to the human decision/execution/cognition processes by the man-machine, man-system, and man-man interfaces. Only by developing adequate data about these interfaces can the aviation industry begin to deal with either preventing the pressures or compensating for them.

RECOMMENDATIONS

The recommendations described below are of two types. The first type consists of new research areas reflecting the safety program voids identified in the evaluation. The second type identifies improvements required in the data collection and the accident investigations areas.

Specifically, these recommendations consist of

a. Pilot error research
b. Pilot/crew awareness
c. Human factors and mechanical data system
d. Citation of cause
e. Collaboration with military researchers
f. Pilot error data feedback.

"Pilot Error" Research

The consensus of safety experts, corroborated by the analysis of accident cause/factor data conducted in this study, is that a comprehensive and continuous "Pilot Error" human factors research program is needed. The present lack of understanding concerning why these errors are occurring mandates that the initial program development be directed toward the areas of human factors data requirements and collection, modeling and similar experimentation. Several human factor models regarding human operator error have been widely discussed by safety experts and should serve as starting points for formulating appropriate hypotheses pertinent to pilot behavior.

The results of such investigations would constitute a sound basis for exploring the following basic areas of pilot error:

a. Man-System Interface
b. Crew Cockpit Coordination/Discipline
c. Decision/Execution/Cognition Error Propagation.

The goal of this programmatic approach is to develop a comprehensive understanding of human factors as possible for use in detecting pilot error situations and initiating prompt corrective actions. The gravity of this problem area is accentuated by the fact that these human errors are occurring in spite of the elaborate mechanical and procedural systems now in place to mitigate these errors.

Pilot/Crew Awareness Program

A program of more immediate nature that should be developed is pilot/ crew awareness training. At the heart of this program would be the open discussion of specific aircraft accidents, and, in particular, the human error events and causes that have been detected in the accident. This information, presented by various human factor accident investigation experts, would be directed at stimulating response and discussion (and thus awareness) in as direct and critical a forum as possible. The general topic areas should cover at least the following:

a. Why was it pilot error?
b. What type of error was committed?
c. Were there mitigating circumstances?
d. Can anything be done to prevent a recurrence?
e. What was the pilot's responsibility in this case?
f. How should the "system" respond to the error?

The program should be developed as initial and recurrent training classes, the intervals of which could be determined with experience. The final facet of the program should be an effective information feedback loop. Any open, two-way discussion between professionals will generate valuable information to improve the program and the system's safety.

Human Factors and Mechanical Data Gathering Systems

One serious problem impairing aircraft accident investigation is the continuing technical problems with some of the onboard aircraft monitoring systems. Complaints center on the cockpit voice recorder (CVR) and the flight data recorder (FDR). These two systems have provided factual and detailed post-crash information which investigators have been able to combine with ground-based data gathering equipment to reconstruct many of the critical facts of an accident. Essentially the problems are ones of reliability and sophistication. The two systems have some technical weaknesses to be corrected. Specifically, these are:

a. An independent power supply system (reserve power for several hours) that activates at the onset of any electrical failure in the aircraft and remains on until ground-based maintenance is performed

b. Improved microphone recording quality and placement

c. Expansion of the recorded flight data to include such things as engine power, control settings and movements, temperatures, warning system indications and electrical buss failures

d. Improved post-crash cockpit voice recorder and flight data recorder survivability.

Citation of Probable Cause

It is recommended that the NTSB re-examine its practice of citing probable cause. This examination should address two problems related to the use of probable cause findings in safety analysis. First, under current policy, the NTSB assigns findings of probable cause in an accident that may include citations in as many as ten different major cause categories. Moreover, no ranking or structuring of these cause citations is made. In accidents involving only mechanical errors, this practice does not impair the identification of safety concerns; but in accidents involving combinations of human, weather, and mechanical error, true cause/effect relationships tend to be masked. Thus, users of the accident findings must interpret, by inference, these reported statements of findings with respect to those that are causal and those that provide supplemental descriptive information.

Further, this multiplicity problem exacerbates the use of probable cause citation involving human error. Because factual human error data is difficult to verify, NTSB's current policy consists of adhering to a framework of observable events in cause citations. This policy apparently stems from two principal considerations: lack of definition of information requirements and accompanying procedures, and institutional issues (liability, privacy, etc.). Future programs for preventing accidents involving human error require that these concerns be overcome. To begin this effort, both the NTSB and the FAA should address the issues involved. First, it is recommended that

NTSB field accident investigation teams include human behavior specialists for all accidents. Further, the NTSB should attempt to widen the range of human error information collected to facilitate the making of valid human factors cause citations.

Second, it is recommended that FAA begin to examine the policy conditions under which the appropriate human behavior data can be gathered, both for accident prevention and accident investigation purposes. This concerns such areas as safeguarding personal privacy rights, use of information in torts/liability claims, and use of the information by investigators.

Collaboration with Military Researchers

A substantial amount of human factors research has been conducted by the various branches of the military service. Information generated in these programs would not necessarily be directly applicable to the commercial aviation industry, but the patterns of pilot decision/execution/cognition error being studied could provide some direction for new areas of research. Apparently, little formal research program coordination exists between the FAA and the safety experts in the military. Most safety experts interviewed during this study expressed the view that significant benefits could be realized in both civil and military aviation by the purposeful cooperation in safety research planning and development.

Pilot Error Data Feedback

The success of the safety programs preventing mechanical failures is due in a large part to the strong, positive data feedback from the accident/incident reporting systems. Analagously, greater success in designing and executing safety programs associated with human error cause/factors would likely follow from implementation of a similar feedback system for pilot error incidents/accidents. This data requirement is, of course, an important component of the pilot error research recommendation. As such, a mechanism should be created by which accident investigators, pilots, or crew members can report, anonymously, if necessary, events and circumstances concerning pilot error. The information would have to be safeguarded and be used solely to build pilot

error profiles for better safety program definition. This type of a pilot error collection system becomes especially important when viewed with respect to the very low frequency of accidents available for study.

FAA REFERENCE DOCUMENTS FOR COMPILING SAFETY PROGRAMS LIST

1. The National Aviation System Challenges of the Decade Ahead--1977-1986, Department of Transportation, Federal Aviation Administration, no date listed.

2. Review of Federal Aviation Administration Activities, Fiscal Year 1975, Department of Transportation, Federal Aviation Administration.

3. Engineering and Development Program Plan - Program Structure and Objectives, July, 1975, Report No. FAA ED-OO-C.

4. An Overview of FAA Engineering and Development Programs with Highlights of Fiscal Years 1975-1976, April, 1975, Report No. FAA EM-75-4.

5. Safety Related Engineering and Development Activities of the FAA, March, 1975, Report No. FAA EM-75-2.

6. Review of FAA Activities Fiscal Year 1974, Department of Transportation, Federal Aviation Administration, no date, no document number.

7. The National Aviation System Plan, March, 1975, Report No. 1000, 27, Appendix 2.

8. Guide to Federal Aviation Administration Publications, June, 1977, Report No. FAA APG-PG-1.

9. 1977 National Aviation System Plan - Draft, April, 1977, Department of Transportation, Federal Aviation Administration.

APPENDIX A

CAUSE/FACTORS AND RELATED CITATION TRENDS

TABLE A-1. TOTAL CAUSE/FACTOR CITATIONS RANKED IN ORDER OF CITATION AS CAUSE

	CAUSES	FACTORS
64*02	213	20
64*01	155	32
82*L	112	6
68*K4	70	5
82*K	63	4
74*00	60	1
84*J	53	--
68*00	48	30
65*02	42	2
68*R	40	2
64*03	32	1
75*00	30	9
68*K0	29	6
82*00	25	118
68*D6	25	2
68*D0	24	3
70*00	21	7
84*00	20	5
70*CE	19	--
70*CA	19	--
70*CB	18	1
80*00	18	19
84*I	15	--
68*D4	14	1
68*K3	13	2
70*CF	13	--
66*02	13	--
82*X	12	27
84*7	12	1
70*CC	10	--
80*0A	9	19
74*ME	8	--
68*G9	8	11
82*H	7	18
75*B0	7	2
64*04	7	2
68*K1	7	1
70*CJ	7	1
82*B	6	27
68*J0	6	--
70*CM	6	--
74*AD	6	--
68*K9	6	1
68*R0	6	--
65*03	4	--
76*00	4	5
65*01	3	4
78*00	3	--
67*01	3	--

TABLE A-1 (Continued)

	CAUSES	FACTORS
75*HA	--	1
80*SE	--	1
74*E0	--	1
80*BL	--	1
80*C9	--	2
80*BS	--	2
68*E4	--	3
68*E0	--	1
68*S5	--	1
80*A3	--	2
75*CL	--	1
68*E2	--	2
80*A5	--	1
68*F9	--	1
66*E9	--	1
80*9C	--	4
76*BY	--	1
80*BJ	--	1
70*D3	--	1
80*A9	--	3
75*CR	--	1
68*M3	--	1
68*G4	--	1
80*BQ	--	1
68*G2	--	1
80*A6	--	1

TABLE A-2. CAUSE/FACTOR CITATIONS BY YEAR

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
64*02	31	16	23	22	29	13	21	10	17	19	13	12	7
64*01	13	14	18	11	15	20	16	16	17	13	9	15	10
84*J	11	11	7	2	2	8	3	2	1	4	1	--	1
82*00	10	20	12	13	16	3	9	13	10	11	6	15	5
65*02	9	4	14	2	4	4	1	1	--	1	2	2	--
82*L	9	13	7	8	10	12	10	8	10	6	14	4	7
68*00	8	10	3	8	6	6	6	6	2	7	4	10	2
74*00	5	9	8	6	2	2	4	2	8	5	3	5	2
82*K	5	2	4	4	10	8	5	6	4	7	5	7	--
82*H	5	2	5	--	1	1	3	1	--	4	--	2	1
68*D0	5	7	6	3	2	1	--	--	--	--	2	1	--
70*00	4	--	4	3	3	1	5	1	3	1	1	2	--
82*B	4	7	3	--	2	2	3	1	2	5	2	1	1
80*00	4	2	3	1	4	1	5	2	--	5	3	4	3
68*K4	3	5	3	4	9	5	5	3	10	4	11	6	7
70*C9	3	3	4	2	3	1	--	--	2	--	--	--	1
70*CH	3	--	1	2	--	--	--	--	--	--	--	--	--
64*I	2	2	3	3	1	1	2	--	--	--	1	--	--
64*03	2	5	1	2	3	5	--	6	3	1	4	--	1
82*X	2	5	1	3	2	4	2	2	6	4	4	3	1
75*00	2	7	3	2	2	3	3	5	3	3	2	3	1
84*7	2	3	1	2	1	1	1	--	--	--	1	--	1
68*J0	2	--	1	2	--	--	--	--	1	--	--	--	--
70*CA	2	1	1	2	1	2	4	2	2	--	--	1	--
70*CE	2	3	3	2	--	1	--	1	1	3	--	3	--
80*3A	2	4	5	1	6	3	1	1	1	3	--	1	--
68*04	2	7	3	1	--	--	--	--	--	--	--	1	1
75*90	2	1	1	2	--	1	1	--	--	--	--	1	--
84*00	1	4	2	2	1	2	1	1	2	5	2	2	--
68*J6	1	1	4	6	4	2	1	2	--	2	--	4	--
68*K3	1	2	--	1	2	2	1	--	1	--	3	--	2
70*CF	1	2	1	--	1	--	1	--	2	1	2	2	--
68*R	1	3	1	4	2	4	3	3	6	6	9	--	--
65*01	1	--	--	--	2	--	--	--	2	--	--	2	--
74*AD	1	1	2	1	1	--	--	--	--	--	--	--	--
75*HA	1	--	--	--	--	--	--	--	--	--	--	--	--
68*K0	--	2	3	5	5	6	1	6	3	--	3	--	1
64*04	--	2	1	--	1	2	1	--	--	1	1	--	--
68*G9	--	--	--	3	--	1	2	5	2	1	4	--	1
70*CJ	--	--	1	--	--	1	3	--	1	1	1	--	--
78*00	--	--	--	--	2	1	--	--	--	--	--	--	--
74*ME	--	3	--	1	--	1	--	1	2	--	--	--	--
66*02	--	1	1	5	2	3	--	1	--	--	--	--	--
65*03	--	1	--	2	--	1	--	--	--	--	--	--	--
68*K9	--	--	1	2	--	2	--	--	1	--	--	--	1
68*R0	--	--	--	--	--	--	--	--	--	--	--	4	2
76*00	--	--	--	1	--	1	--	--	--	3	2	1	1
67*01	--	--	--	--	--	--	1	--	--	--	1	--	1
70*CC	--	2	2	3	3	--	--	--	--	--	--	--	--

TABLE A-2. (Continued)

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
64*02	31	16	23	22	29	13	21	10	17	19	13	12	7
64*01	13	14	18	11	15	20	16	16	17	13	9	15	10
64*J	11	11	7	2	2	8	3	2	1	4	1	--	1
82*00	10	20	12	13	16	3	9	13	10	11	6	15	5
65*02	9	4	14	2	4	4	1	1	--	1	2	2	--
82*L	9	13	7	8	10	12	10	8	10	6	14	4	7
68*00	8	10	3	8	6	6	6	6	2	7	4	10	2
74*00	5	9	8	6	2	2	4	2	8	5	3	5	2
82*K	5	2	4	4	10	8	5	6	4	7	5	7	--
82*H	5	2	5	--	1	1	3	1	--	4	--	2	1
68*D0	5	7	6	3	2	1	--	--	--	--	2	1	--
70*00	4	--	4	3	3	1	5	1	3	1	1	2	--
82*B	4	7	3	--	2	2	3	1	2	5	2	1	1
80*00	4	2	3	1	4	1	5	2	--	5	3	4	3
68*K4	3	5	3	4	9	5	5	3	10	4	11	6	7
70*CB	3	3	4	2	3	1	--	--	2	--	--	--	1
70*CM	3	--	1	2	--	--	--	--	--	--	--	--	--
64*I	2	2	3	3	1	1	2	--	--	--	1	--	--
64*03	2	5	1	2	3	5	--	6	3	1	4	--	1
82*X	2	5	1	3	2	4	2	2	6	4	4	3	1
75*00	2	7	3	2	2	3	3	5	3	3	2	3	1
84*7	2	3	1	2	1	1	1	--	--	--	1	--	1
68*J0	2	--	1	2	--	--	--	--	1	--	--	--	--
70*CA	2	1	1	2	1	2	4	2	2	--	--	1	--
70*CE	2	3	3	2	--	1	--	1	1	3	--	3	--
80*3A	2	4	5	1	6	3	1	1	1	3	--	1	--
68*D4	2	7	3	1	--	--	--	--	--	--	--	1	1
75*90	2	1	1	2	--	1	1	--	--	--	--	1	--
84*00	1	4	2	2	1	2	1	1	2	5	2	2	--
68*D6	1	1	4	6	4	2	1	2	--	2	--	4	--
68*K3	1	2	--	1	2	2	1	--	1	--	3	--	2
70*CF	1	2	1	--	1	--	1	--	2	1	2	2	--
68*R	1	3	1	4	2	4	3	3	6	6	9	--	--
65*01	1	--	--	--	2	--	--	--	2	--	--	2	--
74*AD	1	1	2	1	1	--	--	--	--	--	--	--	--
75*HA	1	--	--	--	--	--	--	--	--	--	--	--	--
68*K0	--	2	3	5	5	6	1	6	3	--	3	--	1
64*04	--	2	1	--	1	2	1	--	--	1	1	--	--
68*G9	--	--	--	3	--	1	2	5	2	1	4	--	1
70*CJ	--	--	1	--	--	1	3	--	1	1	1	--	--
78*00	--	--	--	--	2	1	--	--	--	--	--	--	--
74*ME	--	3	--	1	--	1	--	1	2	--	--	--	--
66*02	--	1	1	5	2	3	--	1	--	--	--	--	--
65*03	--	1	--	2	--	1	--	--	--	--	--	--	--
68*K9	--	--	1	2	--	2	--	--	1	--	--	--	1
68*R0	--	--	--	--	--	--	--	--	--	--	--	4	2
76*00	--	--	--	1	--	1	--	--	--	3	2	1	1
67*01	--	--	--	--	--	--	1	--	--	--	1	--	1
70*CC	--	2	2	3	3	--	--	--	--	--	--	--	--

TABLE A-3. TOTAL ASSOCIATED COSTS OF CAUSE/FACTORS

	CAUSES	FACTORS
64*02	138,960	4,926
80*EA	807	432
82*G	7,951	11,631
82*00	26,640	36,841
84*J	59,562	--
82*H	4,663	434
75*00	12,969	913
82*L	20,941	2,334
68*K4	11,864	74
84*00	36,525	116
70*CA	3,718	--
68*G0	3,468	50
69*00	9,133	1,549
70*00	15,173	3,333
82*K	5,459	23
64*03	35,144	1
70*CB	1,182	--
75*GD	375	141
64*01	90,039	9,723
65*02	19,059	513
80*00	3,002	3,089
74*00	25,656	154
68*J0	4,262	--
70*CE	1,615	--
65*01	632	1,097
70*CM	21	--
63*04	750	40
84*I	54,939	--
82*X	16,960	1,821
63*K3	3,451	75
84*7	6,561	350
63*R	1,943	146
74*AD	48	--
75*FA	--	--
70*CF	2,463	--
68*06	6,085	7
64*04	28,790	4,276
70*CC	317	--
80*BE	--	1
65*02	2,621	--
65*03	2,228	--
63*K0	41,174	120
74*ME	3,069	--
74*E0	--	--
80*LL	--	--
63*K1	62	13
70*CJ	11,574	13
63*K9	733	57
60*C9	--	1,619

TABLE A-3. (Continued)

	CAUSES	FACTORS
68*G9	11,674	11,644
80*CS	--	2
76*00	537	2,857
78*00	4,760	--
68*E4	--	1,372
68*E0	--	141
68*S5	--	10
80*A3	--	55
75*CL	--	1
67*01	476	--
68*E2	--	33
70*EH	135	17
80*A5	--	--
68*N5	274	--
68*F9	--	660
68*E9	--	60
80*EC	--	130
76*EY	--	13
80*EJ	--	--
70*D3	--	73
80*A9	--	713
75*CR	--	155
68*R0	674	--
68*M3	--	41
68*G4	--	3,464
80*E0	--	30
68*G2	--	36
80*A6	--	36

TABLE A-4. ASSOCIATED COSTS OF CAUSE/FACTORS BY YEAR

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
64*02	6,137	9,709	1,674	22,321	16,692	6,426	4,150	4,765	22,667	17,444	18,073	4,063
60*BA	9	20	77	5	133	242	84	39	64	539	--	27
62*B	11	5,006	2,495	--	61	2,008	1,644	2,536	124	1,010	4,237	111
82*00	1,276	2,262	5,736	3,223	3,746	5,605	1,466	6,906	1,968	10,330	522	19,664
64*J	626	7,372	3,256	736	2,475	39,751	150	10,333	323	687	32,725	--
62*H	113	--	221	--	15	1	61	125	--	154	--	--
75*03	5,452	56	32	3,556	121	724	451	1,066	435	275	405	304
62*L	5,912	260	2,150	311	5,627	1,355	1,808	506	372	151	2,775	54
68*K4	4,172	61	41	317	555	146	1,347	41	689	111	686	125
64*00	4,136	47	114	105	161	765	1,090	323	1,464	751	27,590	72
70*CA	--	--	69	449	--	471	950	552	984	--	--	343
68*D0	3	17	97	110	2,315	3	--	--	--	--	625	343
63*00	165	57	24	117	2,314	740	207	918	753	1,563	113	3,675
70*00	--	--	4,091	156	6,690	3	1,197	89	4,011	--	1,179	1,088
62*K	80	80	55	671	2,520	362	134	217	518	236	145	294
64*03	--	3,117	67	2,020	2,557	1,287	--	13,479	3,863	547	8,065	--
70*LB	9	2	334	80	158	47	--	--	293	--	--	--
75*60	--	14	17	94	--	141	22	--	--	--	--	228
64*01	295	1,132	1,567	1,765	7,546	2,704	6,079	14,726	21,440	5,572	23,696	5,346
65*02	114	--	1,052	6,396	251	446	6	101	--	--	11,194	12
60*00	8	1	46	272	2,013	5	3,007	1	--	138	69	32
74*00	9,357	566	497	7,514	499	906	492	868	2,390	472	795	170
68*J0	--	--	67	3,902	--	--	--	--	293	--	--	--
70*CE	--	2	36	428	--	206	--	10	28	751	--	154
65*01	--	--	--	--	711	--	--	--	557	--	--	661
70*CM	11	--	3	7	--	--	--	--	--	--	--	--
66*D4	8	17	46	16	--	--	--	--	--	--	--	229
64*I	8,084	5,784	6,622	653	11,166	2,963	18,037	--	--	--	1,600	--
62*X	3	593	30	50	106	264	41	11	216	2,807	422	14,173
68*K3	188	56	--	1	203	627	169	--	259	--	888	--
64*7	34	8,450	20	62	64	48	28	--	--	--	23	--
63*R	23	63	10	93	56	188	749	183	249	190	287	--
74*A3	--	29	2	10	7	--	--	--	--	--	--	--
75*HA	--	--	--	--	--	--	--	--	--	--	--	--
70*CF	--	--	2	--	15	--	57	--	554	293	82	1,457
68*D6	--	192	242	139	2,415	61	1	99	--	431	--	2,509
64*04	--	9,377	9,729	--	6,498	2,273	403	--	--	47	4,223	--
70*CC	--	--	73	65	158	--	--	--	--	--	--	--
60*DE	--	1	--	--	--	--	--	--	--	--	--	--
65*02	--	--	171	1,729	514	207	--	--	--	--	--	--
65*03	--	--	--	2,022	--	206	--	--	--	--	--	--
68*K0	--	1,427	633	18,271	1,623	1,336	7	13,479	4,211	--	--	--
74*ME	--	40	--	232	--	508	--	505	1,784	--	--	--
74*E0	--	--	--	--	--	--	--	--	--	--	--	--
80*BL	--	--	--	--	--	--	--	--	--	--	--	--
63*K1	--	--	--	62	--	--	--	--	13	--	--	--
70*CJ	--	--	67	--	--	3	11,115	--	66	265	51	--
68*K9	--	--	57	330	--	51	--	--	259	--	--	--
80*C9	--	--	--	1,615	--	--	--	--	--	--	--	--

TABLE A-4. (Continued)

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
68*G9	--	--	--	6,873	--	80	83	1,752	2,058	2,722	10,115	--
80*BS	--	--	--	2	--	--	--	--	--	--	--	--
76*00	--	--	--	5	--	51	--	--	--	2,798	49	49
78*00	--	--	--	--	4,736	24	--	--	--	--	--	--
68*E4	--	--	--	--	116	--	--	--	--	--	--	155
68*E0	--	--	--	--	--	141	--	--	--	--	--	--
68*S5	--	--	--	--	--	10	--	--	--	--	--	--
80*A3	--	--	--	--	--	55	--	--	--	--	--	--
75*CL	--	--	--	--	--	--	1	--	--	--	--	--
67*01	--	--	--	--	--	--	84	--	--	--	--	--
68*E2	--	--	--	--	--	--	--	26	--	5	--	--
70*LH	--	--	--	--	--	--	--	--	17	135	--	--
80*A5	--	--	--	--	--	--	--	--	--	--	--	--
68*NS	--	--	--	--	--	--	--	--	--	274	--	--
68*F9	--	--	--	--	--	--	--	--	--	660	--	--
68*E9	--	--	--	--	--	--	--	--	--	--	60	--
80*BC	--	--	--	--	--	--	--	--	--	--	89	41
76*BY	--	--	--	--	--	--	--	--	--	--	13	--
80*BJ	--	--	--	--	--	--	--	--	--	--	--	--
70*D3	--	--	--	--	--	--	--	--	--	--	73	--
80*A9	--	--	--	--	--	--	--	--	--	--	--	719
75*CR	--	--	--	--	--	--	--	--	--	--	--	155
68*K0	--	--	--	--	--	--	--	--	--	--	--	85
68*M3	--	--	--	--	--	--	--	--	--	--	--	41
68*G4	--	--	--	--	--	--	--	--	--	--	--	3,464
80*BU	--	--	--	--	--	--	--	--	--	--	--	30
68*G2	--	--	--	--	--	--	--	--	--	--	--	--
80*A6	--	--	--	--	--	--	--	--	--	--	--	--

TABLE A-5. TYPE OF ACCIDENT BY YEAR

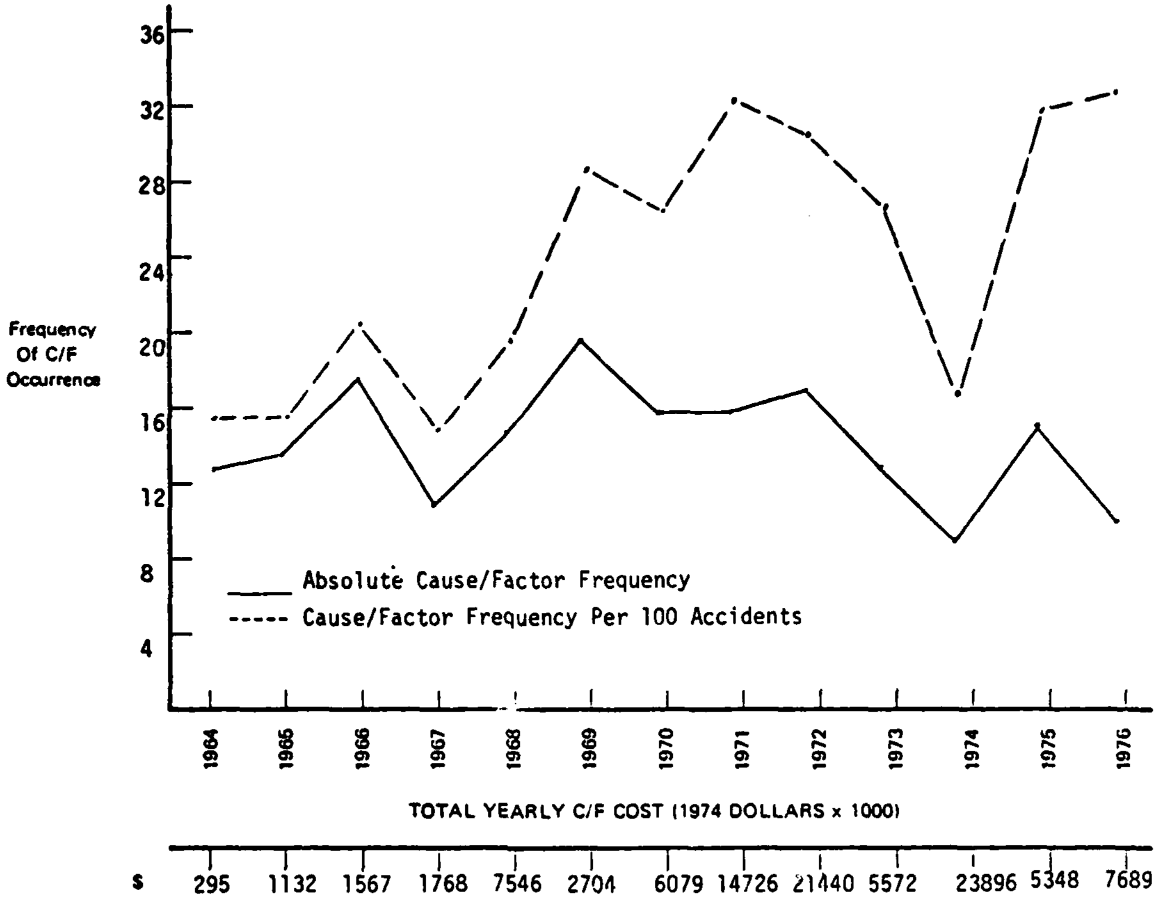
		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
A	GROUND-WATER LOOP/SWERVE	7	2	6	5	5	2	1	5	--	2	1	1	--
B	DRAGGED WINGTIP,POD,FLOAT	--	2	--	--	--	--	--	--	--	--	--	--	--
C	WHEELS UP	5	1	2	6	3	--	2	1	1	--	--	--	--
D	WHEELS-DOWN LADING WATER	--	--	--	--	1	--	1	--	--	--	--	--	--
E	GEAR COLLAPSED	7	5	5	7	4	5	4	1	3	2	--	4	3
F	GEAR RETRACTED	4	2	4	3	1	--	1	--	--	1	--	--	--
G	HARD LANDING	3	4	8	1	1	5	3	--	4	2	1	1	--
H	NOSE OVER/DOWN	2	--	--	--	--	--	1	1	--	--	--	1	1
I	ROLL OVER	--	--	--	--	--	--	--	--	--	--	--	--	--
J	OVERSHOOT	5	3	3	1	1	2	--	--	--	3	--	2	4
K	UNDERSHOOT	5	5	4	4	5	--	2	--	--	3	1	3	--
L0	COLLISION IN FLIGHT	--	2	2	6	6	6	--	8	2	--	--	--	--
L1	COLLISION ONE AIRBORNE	--	--	--	--	--	--	--	--	2	--	--	--	--
L2	COLLISION BOTH ON GROUND	--	--	--	4	2	4	--	--	2	--	4	--	--
M0	COLLISION WITH GRD/WATER CONTROLLED	3	7	2	--	4	1	2	3	1	3	3	2	1
M1	COLLISION WITH GRD/WATER UNCONTROLLED	4	--	2	3	2	4	1	1	1	1	--	1	2
N0	COLLIDED-WIRES/POLES	1	--	--	--	--	--	--	1	--	--	--	--	--
N1	COLLIDED -TREES	--	1	2	1	3	1	3	--	--	--	--	--	--
N2	COLLIDED-RESIDENCE	--	--	--	--	--	--	--	1	--	--	--	--	--
N3	COLLIDED -OTHER BUILDINGS	--	--	2	--	--	--	--	--	--	--	1	--	--
N4	COLLIDED-FENCE,FENCEPOSTS	1	--	1	--	--	--	--	--	1	--	--	--	--
N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--	--	--	--	1	--	--	--	--	--	--	--	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	--	--	--	--	--	--	1	2	--	1	1	--
N7	COLLIDED-AIRPORT HAZARD	--	--	1	--	--	--	--	--	--	--	1	--	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	--	--	--	--	--	--	--	--	--	--	--	--
N9	COLLIDED-CROP	--	--	--	--	--	--	--	--	--	--	--	--	--
NA	COLLIDED-FLAGMAN,LOADER	--	--	--	--	--	--	--	--	--	--	--	--	--
NB	COLLIDED-DITCHES	--	--	--	--	1	--	1	--	--	--	--	1	1
NC	COLLIDED-SNOWBANK	1	1	--	--	--	--	1	--	--	--	1	--	--
ND	COLLIDED-PARKED AIRCRAFT	2	2	1	--	--	2	1	--	1	1	1	--	--
NE	COLLIDED - AUTOMOBILE	--	1	--	--	--	1	--	--	--	--	--	--	--
NF	COLLIDED -DIRT BANK	--	--	--	--	--	1	--	--	--	--	--	--	--
NY	COLLIDED-OTHERP BIRD STRIKE	1	1	--	4	--	2	2	1	1	3	1	--	1
Q1	STALL SPIN	--	--	--	--	--	--	--	--	--	--	--	--	--
Q2	STALL-SPIRAL	--	--	--	--	--	--	--	--	--	--	1	--	--
Q3	STALL -MUSH	2	2	--	--	1	--	--	--	1	--	--	--	--
R0	FIRE IN FLIGHT	3	1	--	5	1	--	1	--	--	1	2	--	1
R1	FIRE ON GROUND	1	2	--	--	1	1	5	1	4	--	--	4	--
S0	AIRFRAME FAILURE IN FLIGHT	--	1	2	1	--	--	--	1	1	--	2	1	1
S1	AIRFRAME FAILURE ON GROUND	--	2	--	--	--	--	--	--	2	1	3	2	--
T	ENGINE TEARAWAY	--	--	--	--	--	--	--	--	--	--	--	--	--
U	ENGINE FAILURE OR MALFUNCTION	4	12	9	4	2	5	5	2	7	5	1	7	1
V1	PROPELLER FAILURE	--	--	1	2	--	--	--	1	2	--	--	--	1
V2	TAIL ROTOR FAILURE	--	--	--	--	--	--	--	--	--	--	--	--	--
V3	MAIN ROTOR FAILURE	--	--	--	--	2	--	--	--	--	--	--	--	--
W	PROPELLER/ROTOR ACCIDENT-PERSON	--	2	--	--	3	3	1	--	1	--	--	--	1
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	--	--	--	--	--	--	--	--	--	--	--	--
Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--	--	--	--	--	--	--	--	--	--	--	--	--
Z	TURBULENCE	11	14	11	13	22	21	16	14	15	14	17	12	7

TABLE A-5. (Cont'd)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
0	HAIL DAMAGE TO AIRCRAFT	--	2	--	--	--	--	--	--	--	--	1	--	--
1	LIGHTING STRIKE	--	1	--	--	--	--	1	--	--	--	--	--	--
2	EVASIVE MANEUVER	2	3	1	2	1	1	1	--	--	--	1	1	1
3	UNCONTROLLED ALTITUDE DEVIATION	--	--	--	1	--	--	--	--	--	--	[illegible]	--	--
4	DITCHING	--	--	--	--	--	--	--	--	--	--	--	--	--
5	MISSING AIRCRAFT	--	--	--	--	--	--	--	--	--	--	1	--	--
6	MISCELLANEOUS/OTHER	4	3	6	3	5	6	2	9	3	6	8	2	4
7	UNDETERMINED	--	--	1	--	--	--	--	--	--	--	--	--	--

APPENDIX B

CAUSE/FACTOR FREQUENCY AND COST SUMMARY



TOTAL ASSOCIATED FATALITIES 1,040

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 155
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 32

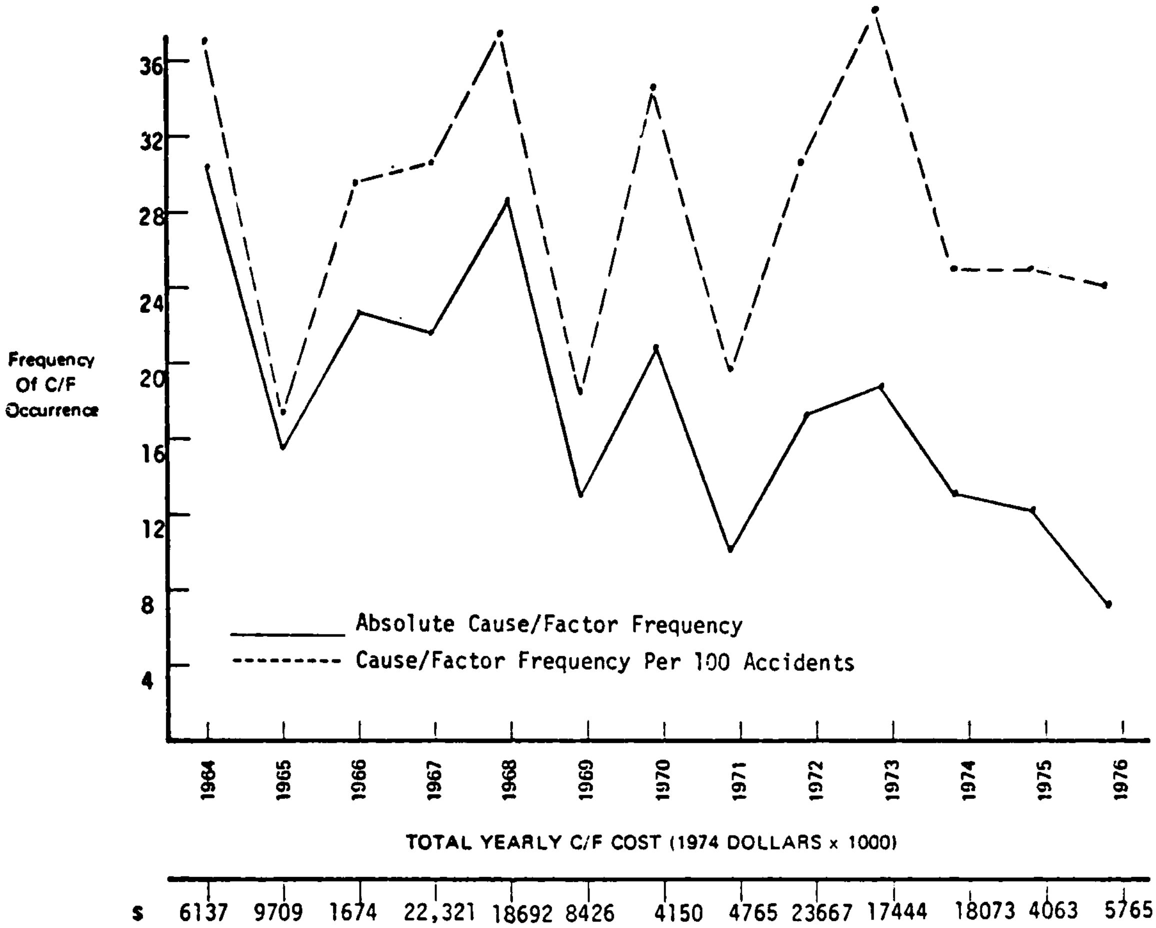
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 187

TOTAL ASSOCIATED COST AS CAUSE 90,039
TOTAL ASSOCIATED COST AS FACTOR 9,723

TOTAL ASSOCIATED COST AS BOTH 99,762

DIRECTLY ALIGNED SAFETY PROGRAMS . . . .None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .221,302, 412

FIGURE B-1. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PILOT-DECISION ERROR (64*01)



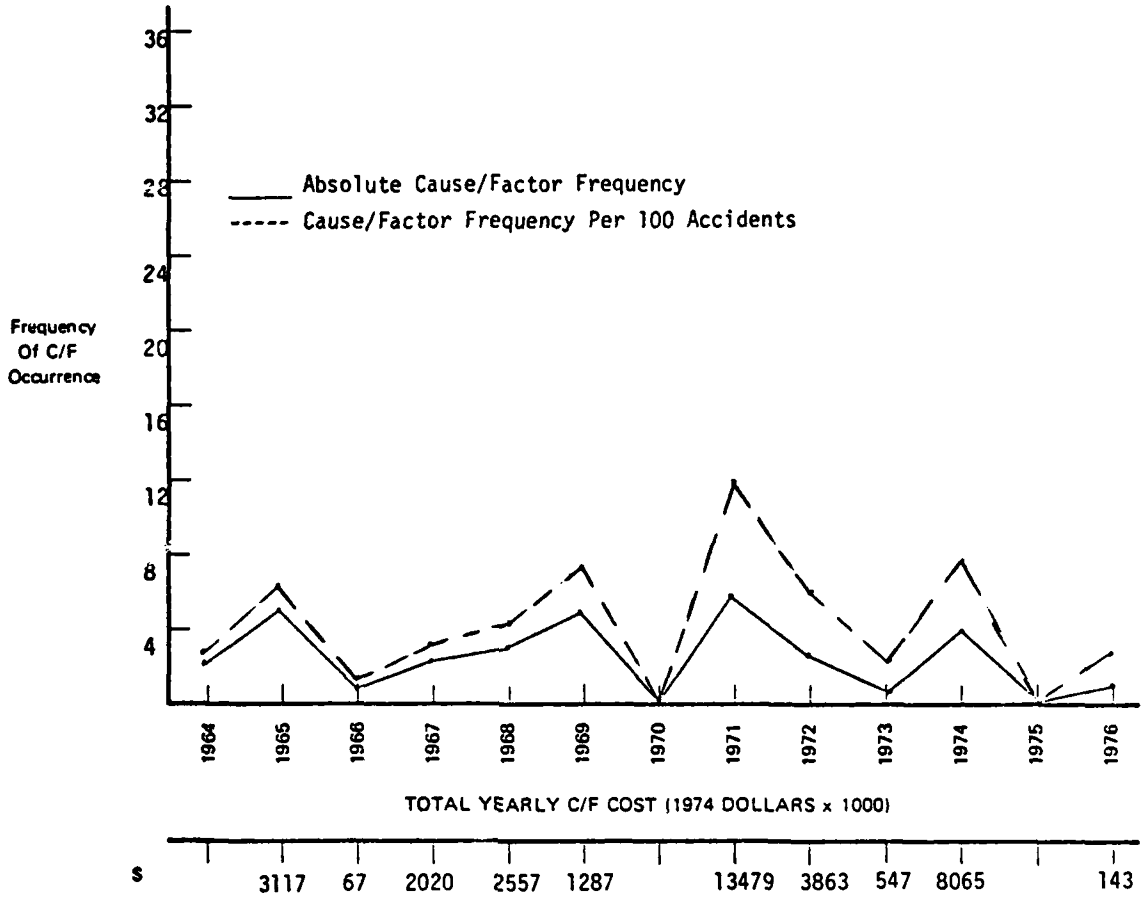
TOTAL ASSOCIATED FATALITIES. 1,148

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 213
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 20
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 233

TOTAL ASSOCIATED COST AS CAUSE 138,960
TOTAL ASSOCIATED COST AS FACTOR 4,926
TOTAL ASSOCIATED COST AS BOTH 143,886

DIRECTLY ALIGNED SAFETY PROGRAMS 218
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .106, 107, 108, 109, 111, 115
205, 214, 220, 221

FIGURE B-2. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PILOT-EXECUTION (64*02)



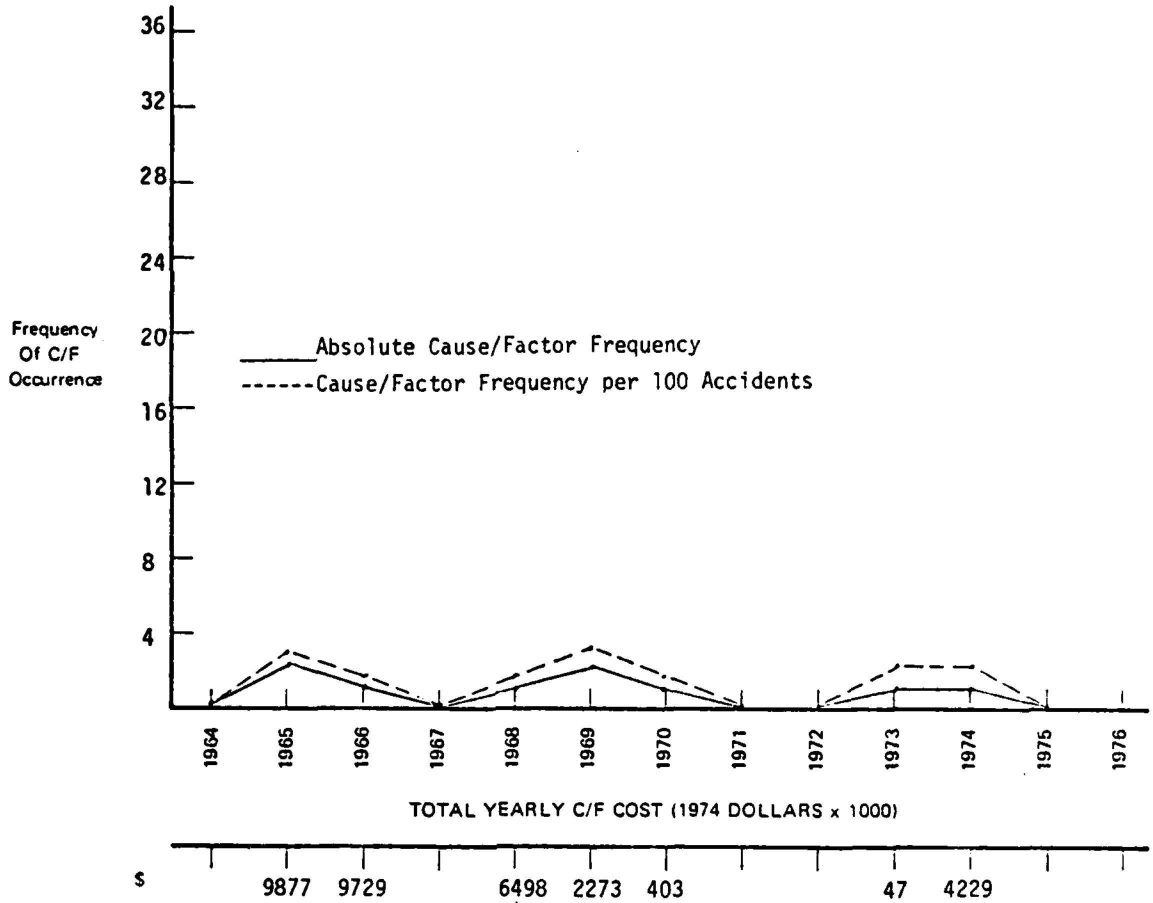
TOTAL ASSOCIATED FATALITIES. 332

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . 32
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 1
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 33

TOTAL ASSOCIATED COST AS CAUSE 35,144
TOTAL ASSOCIATED COST AS FACTOR -
TOTAL ASSOCIATED COST AS BOTH. 35,145

DIRECTLY ALIGNED SAFETY PROGRAMS 309
INDIRECTLY ALIGNED SAFETY PROGRAMS 202, 206, 223

FIGURE B-3. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PILOT-COGNITION (64*03)



TOTAL ASSOCIATED FATALITIES. 336

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . . 7
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 2

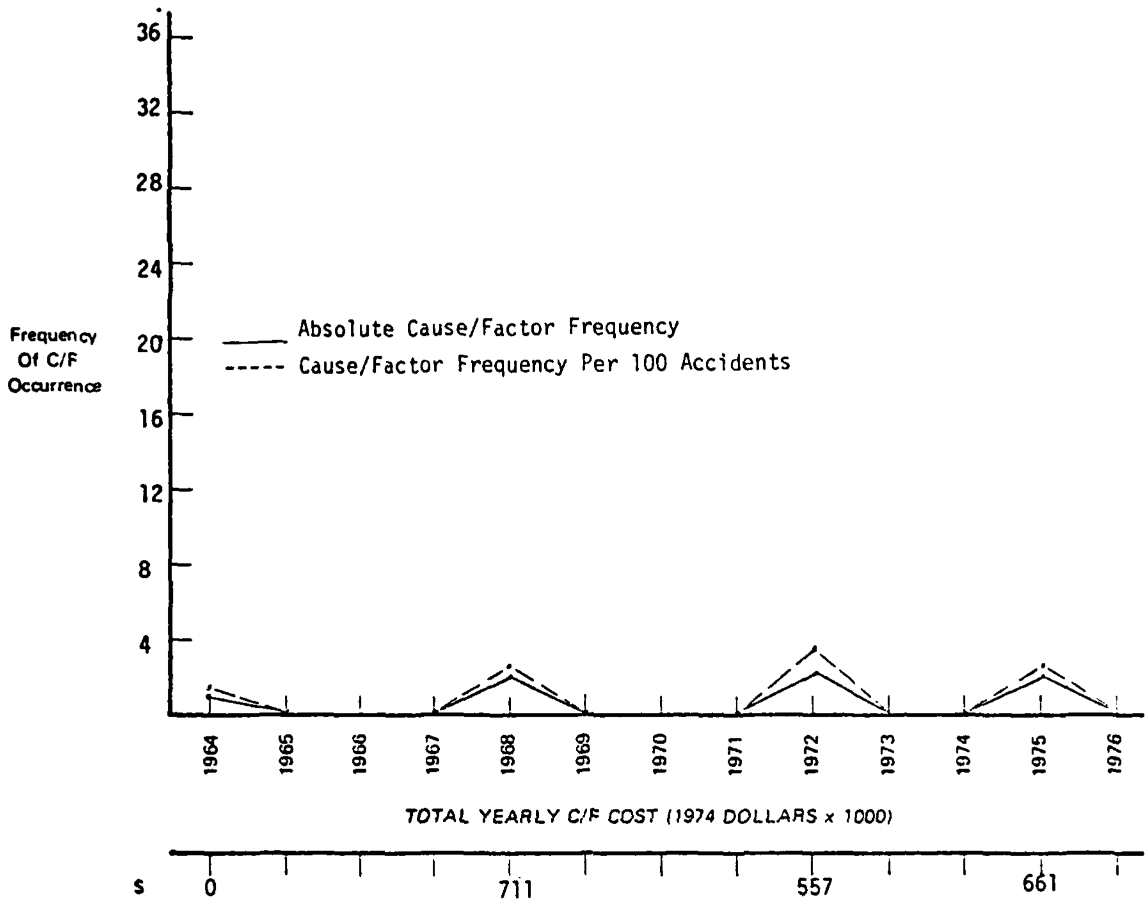
TOTAL ACCIDENTS ASSOCIATED AS BOTH 9

TOTAL ASSOCIATED COST AS CAUSE 28,780
TOTAL ASSOCIATED COST AS FACTOR. 4,276

TOTAL ASSOCIATED COST AS BOTH. 33,056

DIRECTLY ALIGNED SAFETY PROGRAMS. . . . 222, 415
INDIRECTLY ALIGNED SAFETY PROGRAMS. . . None

FIGURE B-4. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PILOT-PHYSICAL INCAPACITATION (64*04)



TOTAL ASSOCIATED FATALITIES 46

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . 3
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . 4

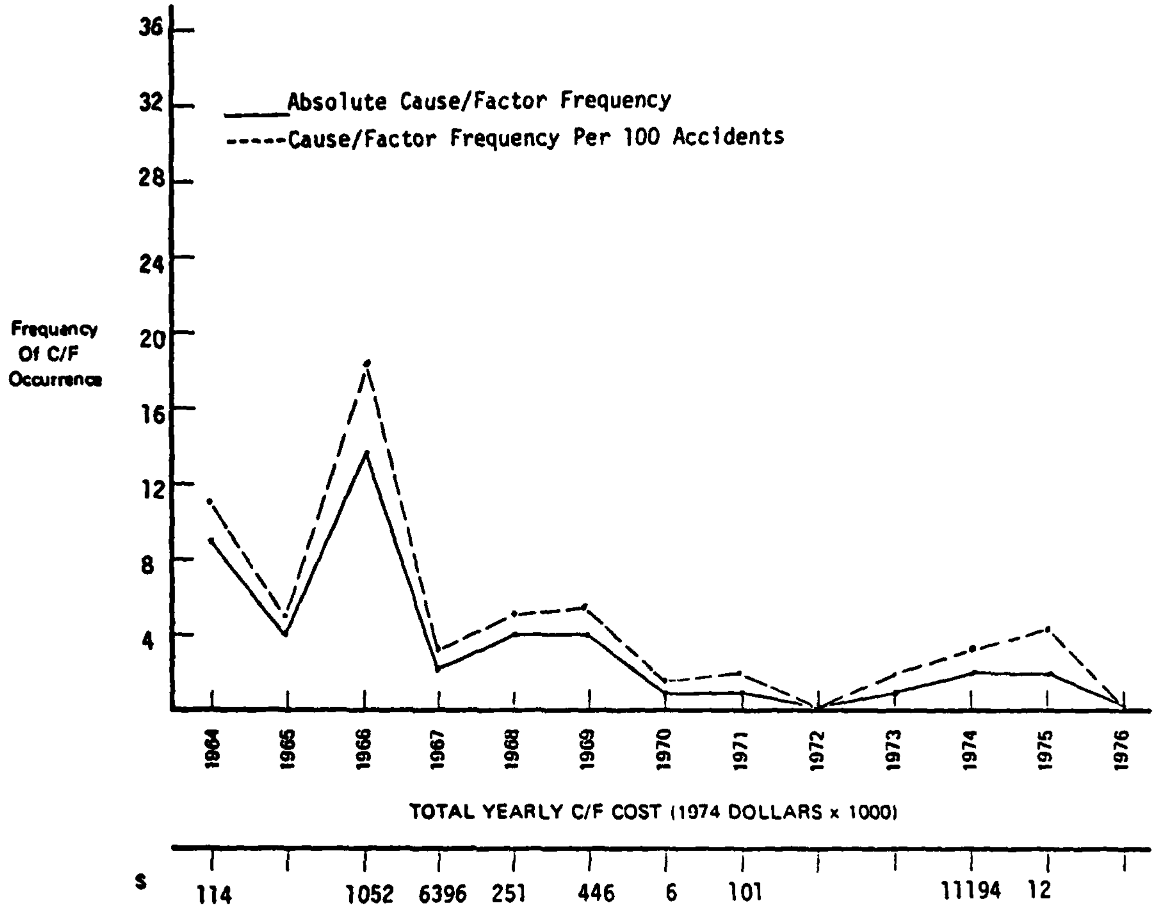
TOTAL ACCIDENTS ASSOCIATED AS BOTH. . . 7

TOTAL ASSOCIATED COST AS CAUSE. . . . 832
TOTAL ASSOCIATED COST AS FACTOR . . 1,097

TOTAL ASSOCIATED COST AS BOTH . . . 1,929

DIRECTLY ALIGNED SAFETY PROGRAMS . None
INDIRECTLY ALIGNED SAFETY PROGRAMS Same as 64*01

FIGURE B-5. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: COPILOT-DECISION (65*01)



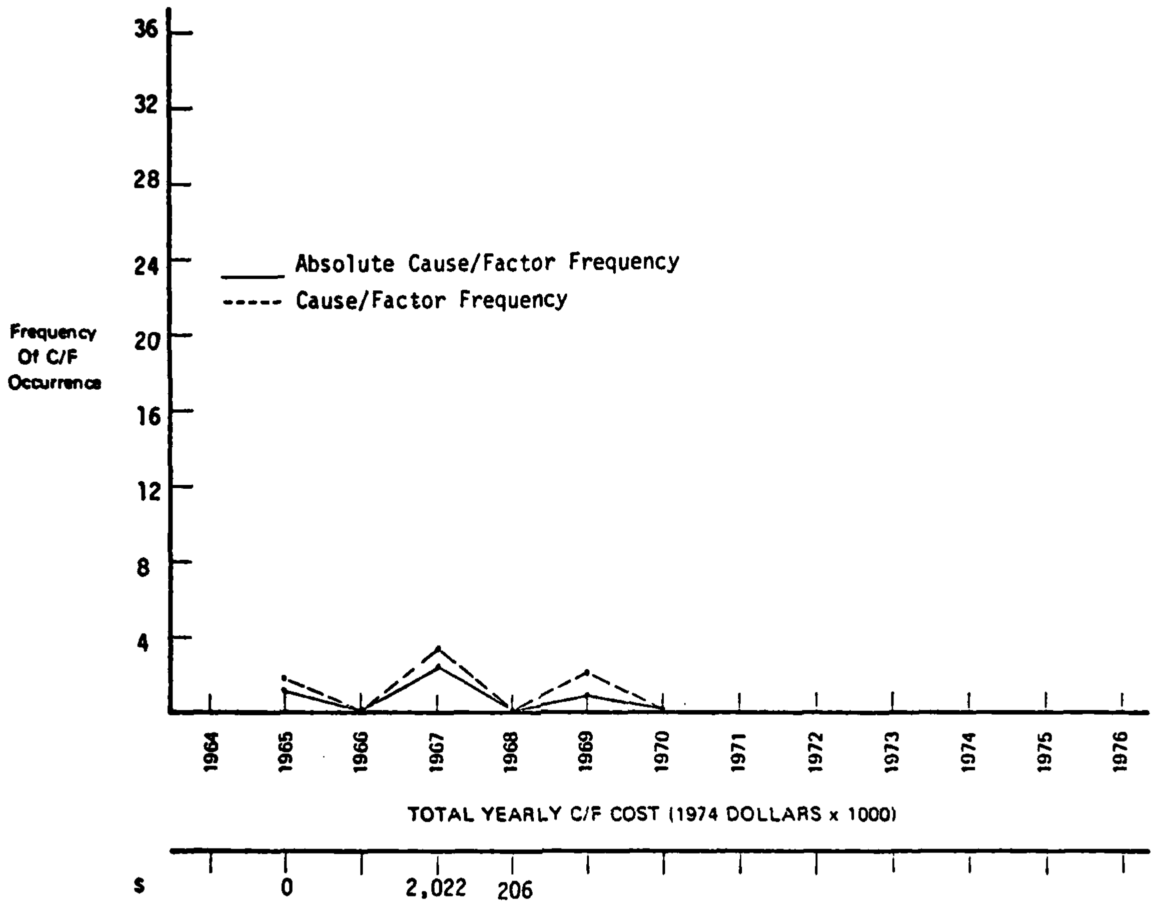
TOTAL ASSOCIATED FATALITIES 167

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 42
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 2
TOTAL ACCIDENTS ASSOCIATED AS BOTH. 44

TOTAL ASSOCIATED COST AS CAUSE. 19,059
TOTAL ASSOCIATED COST AS FACTOR 513
TOTAL ASSOCIATED COST AS BOTH 19,572

DIRECTLY ALIGNED SAFETY PROGRAMS . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . Same as 64*02

FIGURE B-6. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: COPILOT-EXECUTION (65*02)



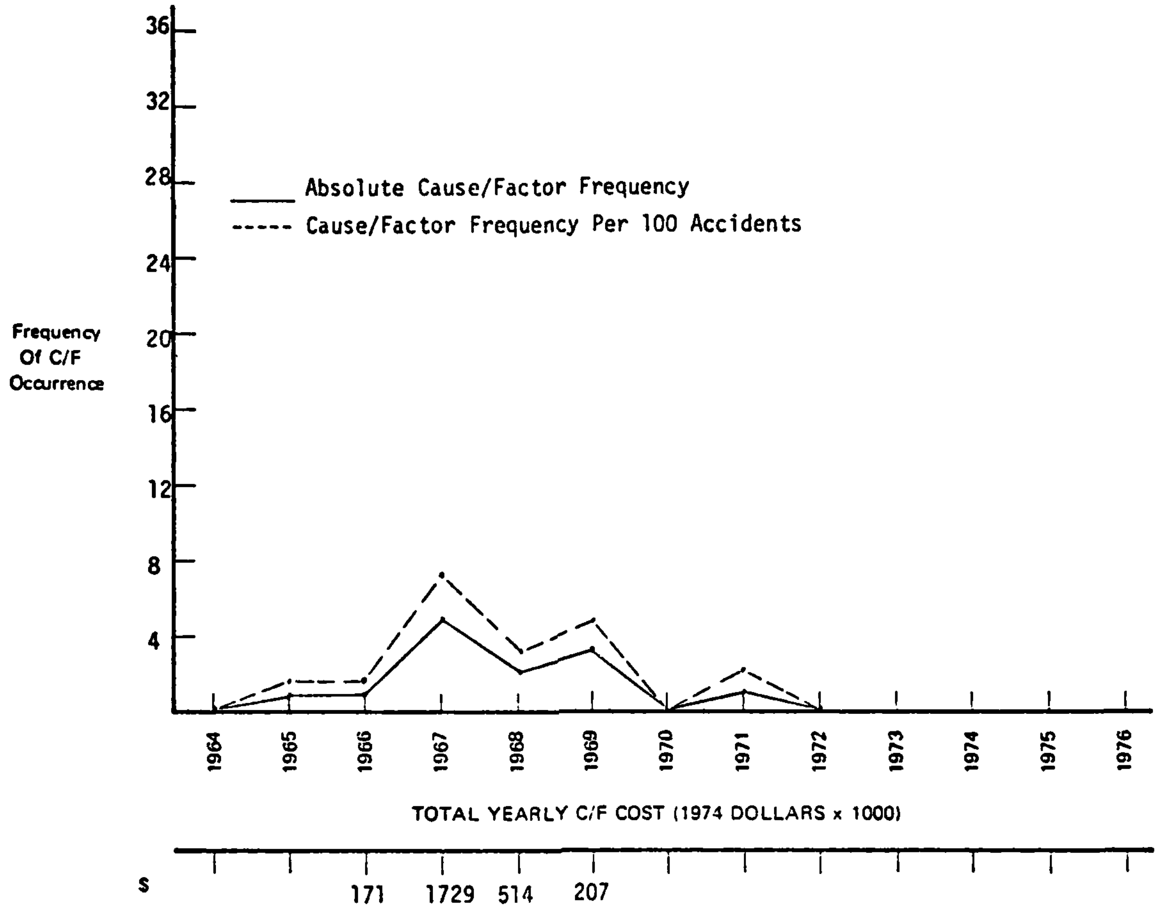
TOTAL ASSOCIATED FATALITIES. 26

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . . 4
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH 4

TOTAL ASSOCIATED COST AS CAUSE 2,228
TOTAL ASSOCIATED COST AS FACTOR . . . . -
TOTAL ASSOCIATED COST AS BOTH. 2,228

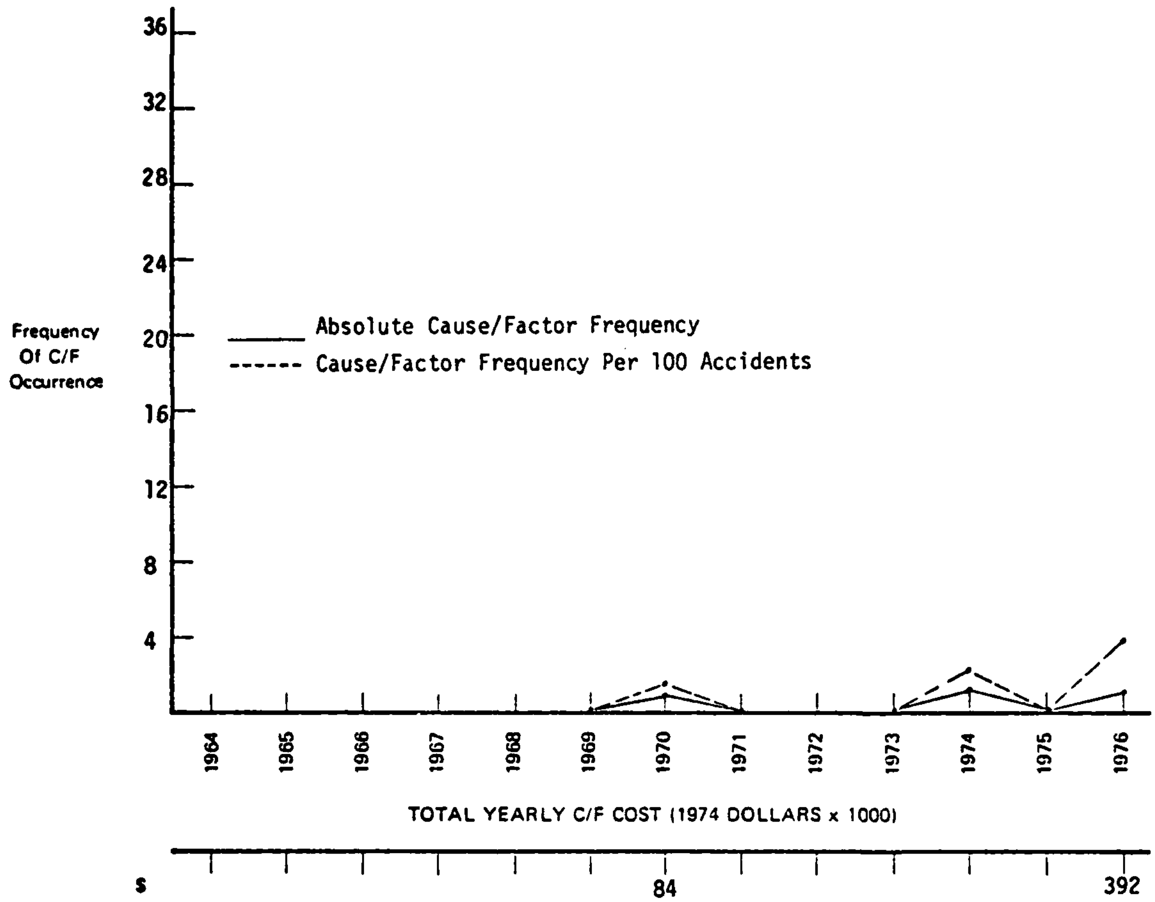
DIRECTLY ALIGNED SAFETY PROGRAMS . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . . Same as 64*03

FIGURE B-7. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: COPILOT-COGNITION (65*03)



TOTAL ASSOCIATED FATALITIES	38
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	13
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	0
TOTAL ACCIDENTS ASSOCIATED AS BOTH. . .	13
TOTAL ASSOCIATED COST AS CAUSE.	2,621
TOTAL ASSOCIATED COST AS FACTOR	-
TOTAL ASSOCIATED COST AS BOTH	2,621
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	Same as 64*02

FIGURE B-8. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: STUDENT-EXECUTION (66*02)



TOTAL ASSOCIATED FATALITIES 0

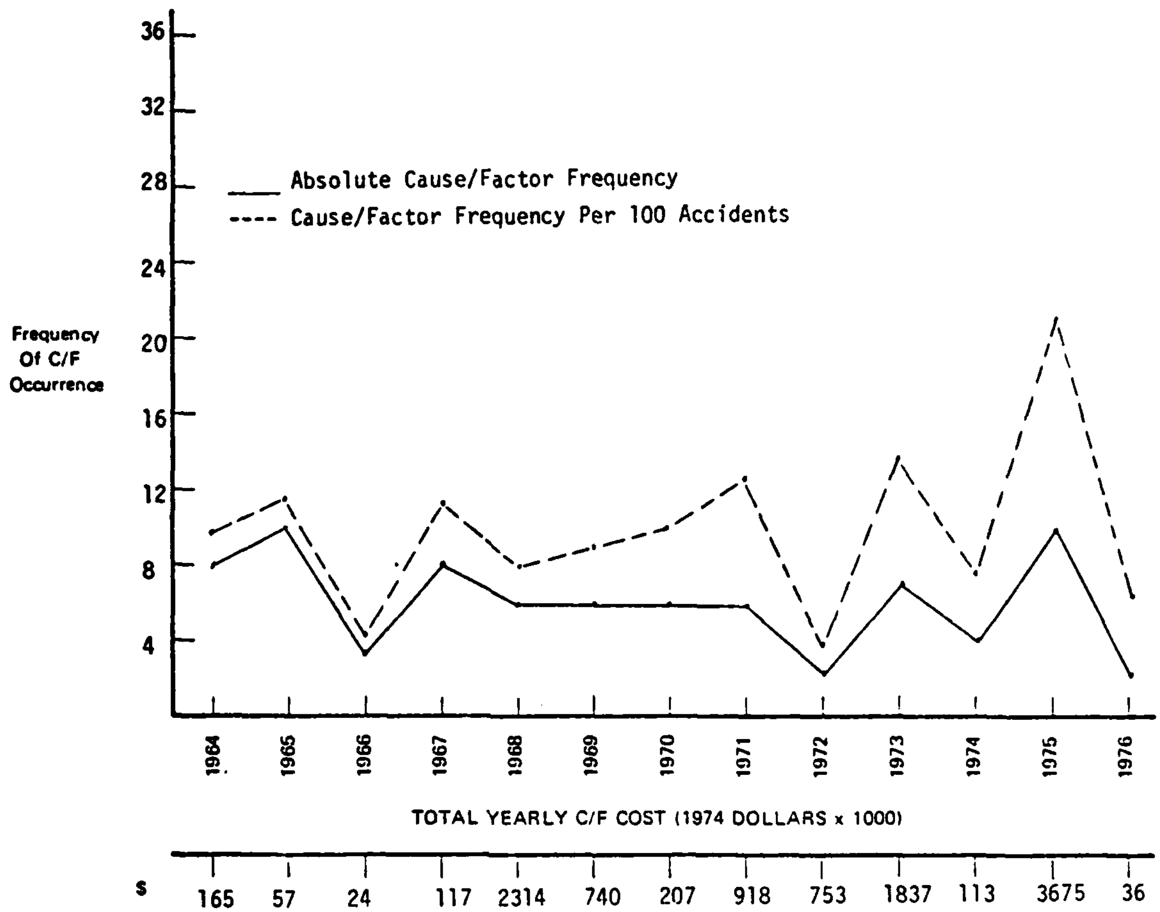
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . 3
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . 3

TOTAL ASSOCIATED COST AS CAUSE. 476
TOTAL ASSOCIATED COST AS FACTOR . . . . -
TOTAL ASSOCIATED COST AS BOTH 476

DIRECTLY ALIGNED SAFETY PROGRAMS . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . Same as 64*01

FIGURE B-9. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: CHECK PILOT-DECISION (67*01)

68*00 includes J6, ND, N1, N5, J2, D2, FO, E3, H2, E1, S2, G1, G3, HO, H1, S8, S4, E5, H9, M5, J1, D8, K5, S1, G6



TOTAL ASSOCIATED FATALITIES 113

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 48
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 30

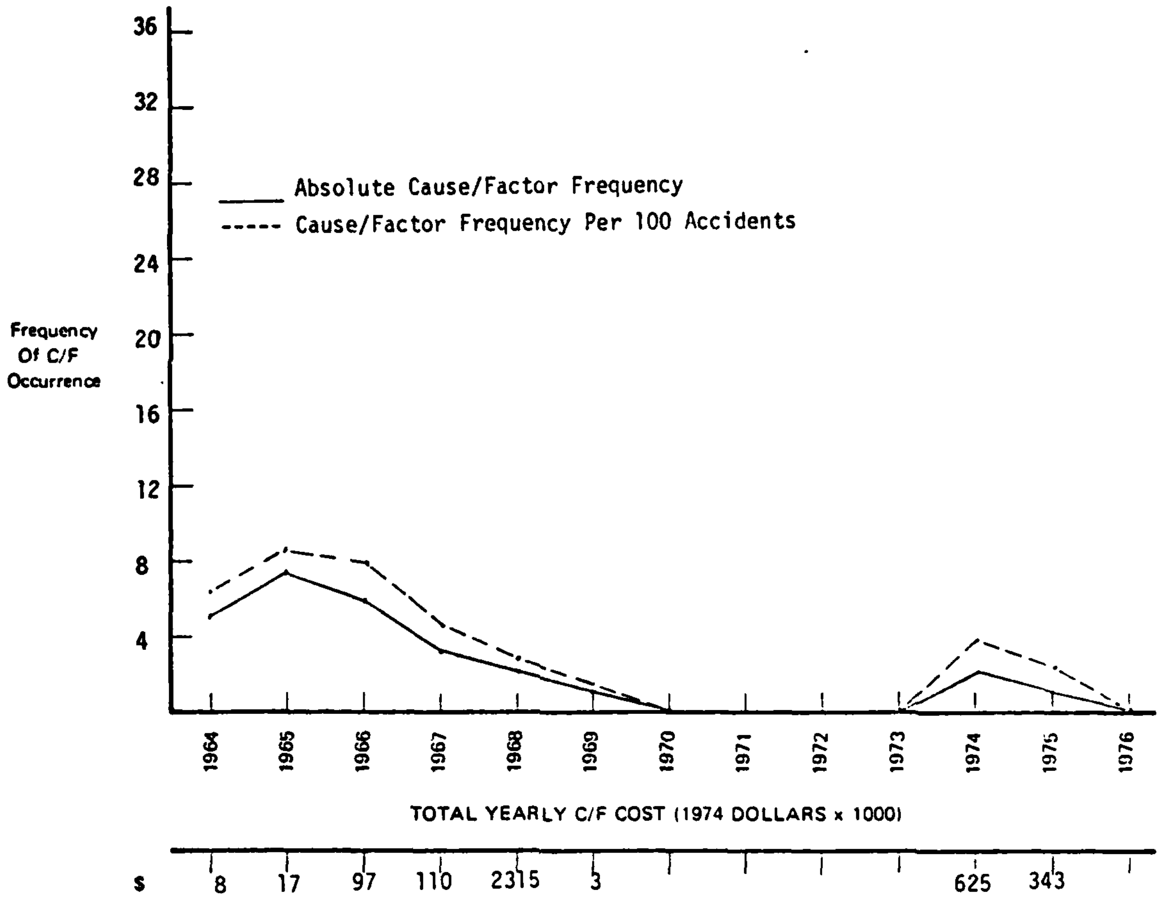
TOTAL ACCIDENTS ASSOCIATED AS BOTH. . . . 78

TOTAL ASSOCIATED COST AS CAUSE 9,407
TOTAL ASSOCIATED COST AS FACTOR 1,549

TOTAL ASSOCIATED COST AS BOTH 10,956

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . 102, 103, 224, 310, 311, 312, 402, 411, 413, 414, 415, 419 422 601, 607

FIGURE B-10. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-MISC. (68*00)



TOTAL ASSOCIATED FATALITIES 39

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 24
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 3

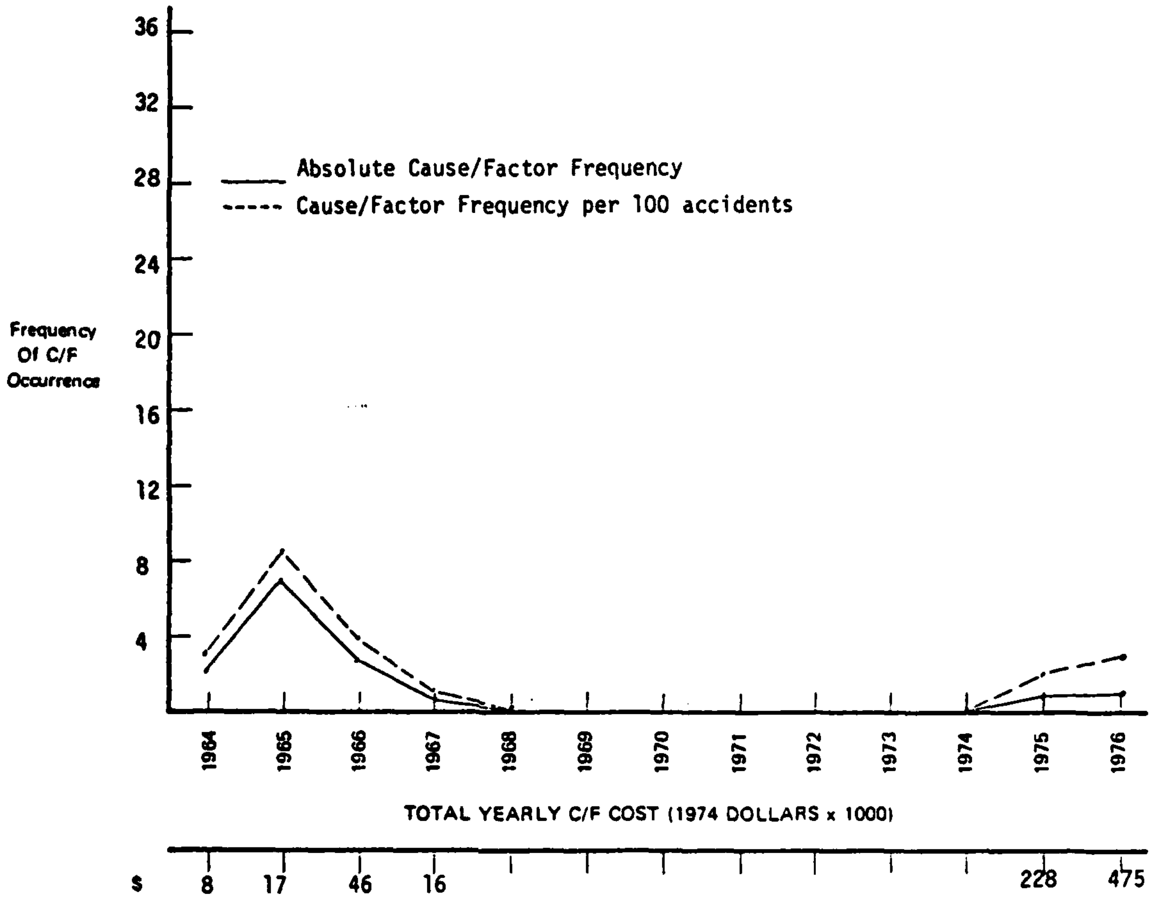
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 27

TOTAL ASSOCIATED COST AS CAUSE 3,468
TOTAL ASSOCIATED COST AS FACTOR 50

TOTAL ASSOCIATED COST AS BOTH 3,518

DIRECTLY ALIGNED SAFETY PROGRAMS 411
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . None

FIGURE B-11. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-IMPROPER MAINTENANCE (68*DO)



TOTAL ASSOCIATED FATALITIES 3

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . 14
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . 1

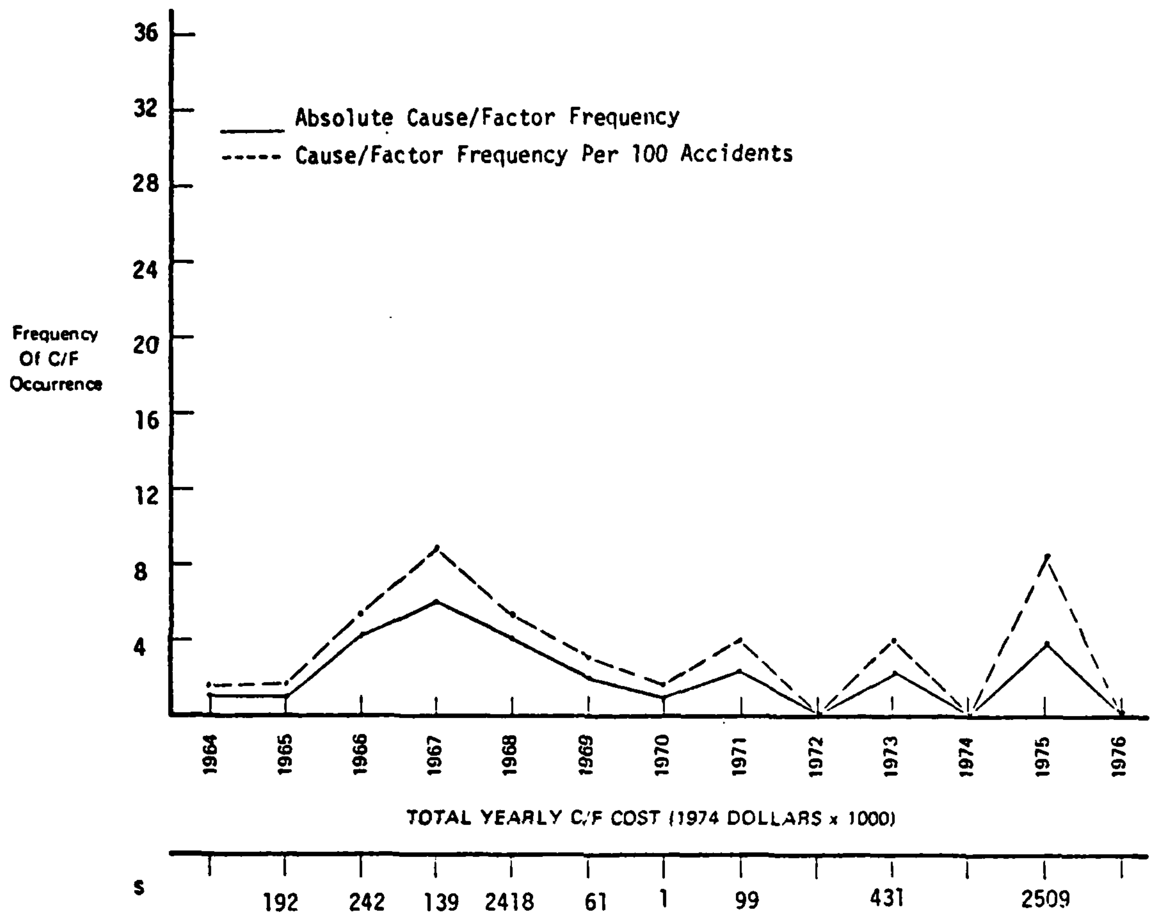
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . 15

TOTAL ASSOCIATED COST AS CAUSE 750
TOTAL ASSOCIATED COST AS FACTOR 40

TOTAL ASSOCIATED COST AS BOTH 790

DIRECTLY ALIGNED SAFETY PROGRAMS . . . 411
INDIRECTLY ALIGNED SAFETY PROGRAMS . . 419

FIGURE B-12. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-INADEQUATE INSPECTION (68*D4)



TOTAL ASSOCIATED FATALITIES 23

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 25
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 2

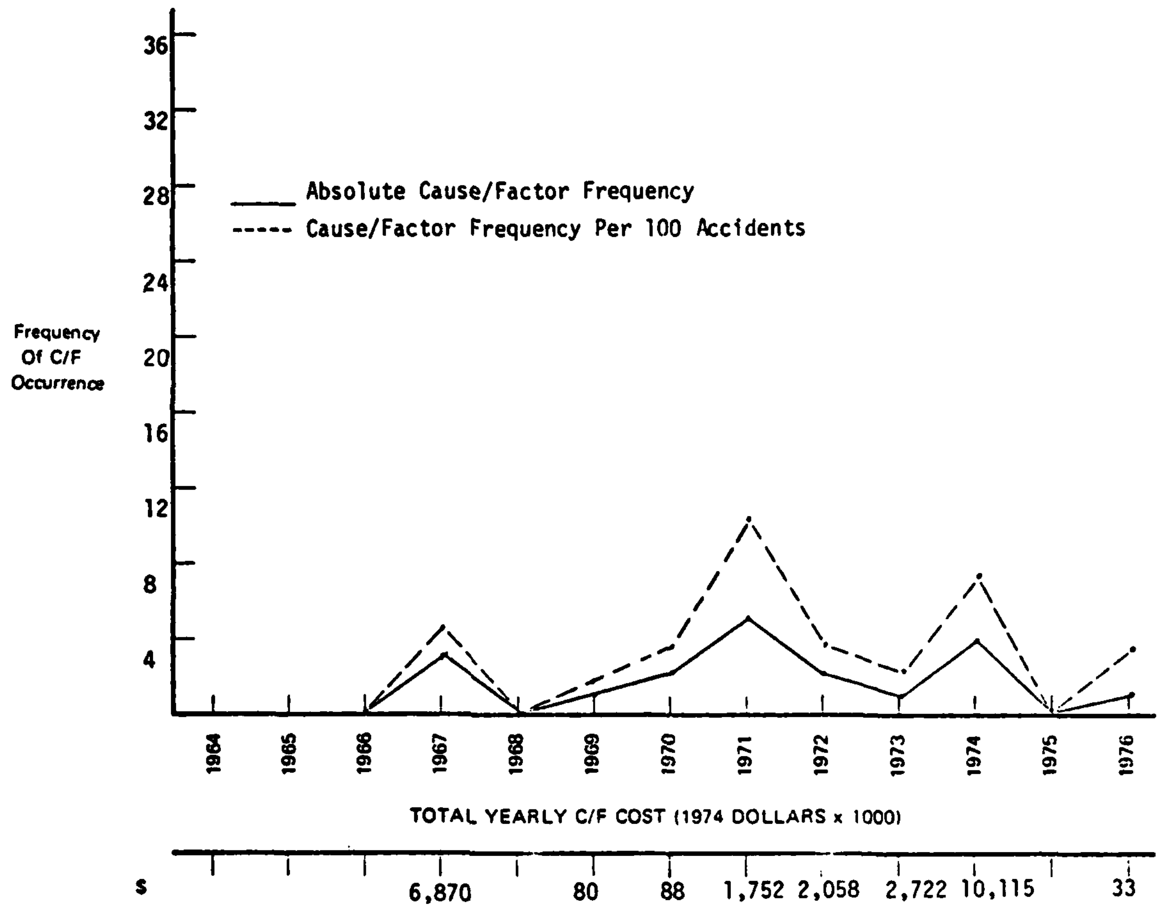
TOTAL ACCIDENTS ASSOCIATED AS BOTH 27

TOTAL ASSOCIATED COST AS CAUSE 6,085
TOTAL ASSOCIATED COST AS FACTOR 7

TOTAL ASSOCIATED COST AS BOTH 6,092

DIRECTLY ALIGNED SAFETY PROGRAMS 411
INDIRECTLY ALIGNED SAFETY PROGRAMS 419

FIGURE B-13. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-INADEQUATE MAINTENANCE (68*D6)



TOTAL ASSOCIATED FATALITIES. 464

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . 8
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 11

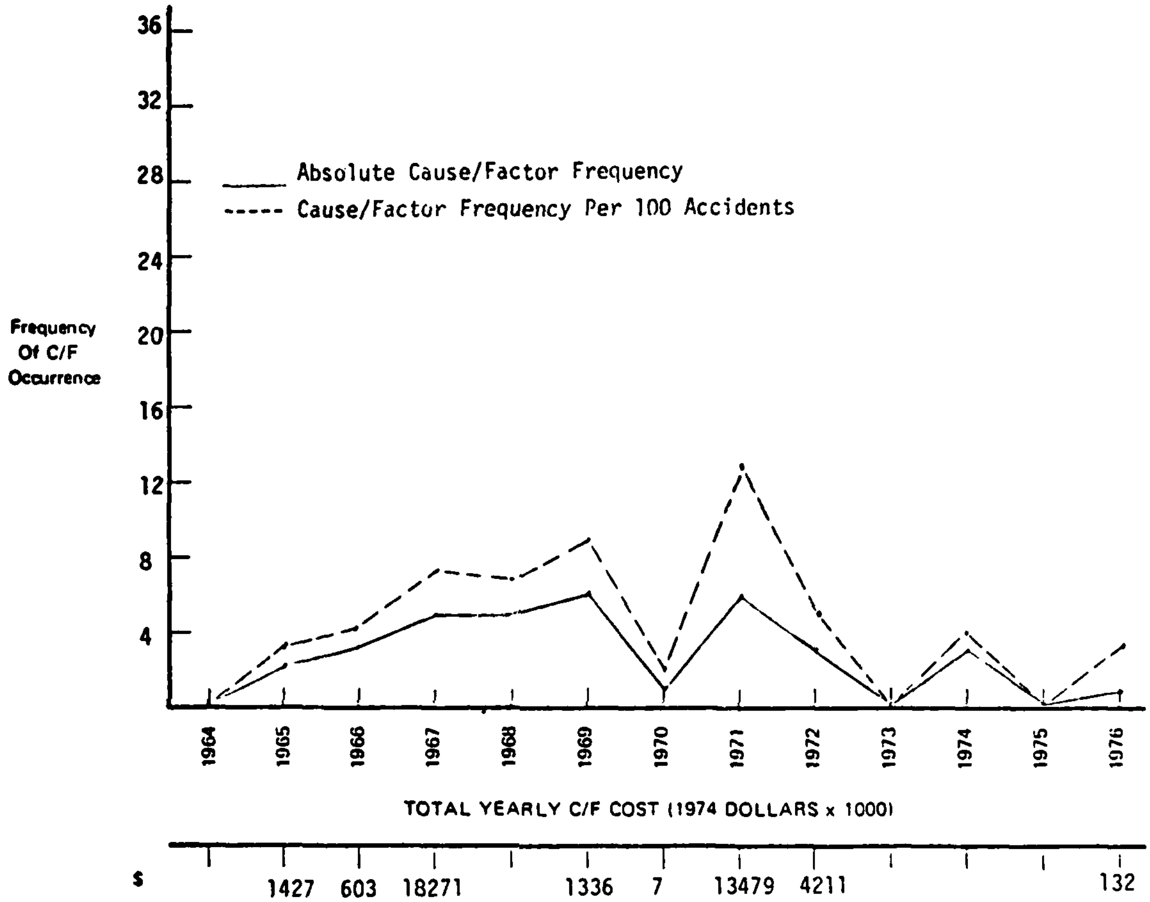
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 19

TOTAL ASSOCIATED COST AS CAUSE 11,874
TOTAL ASSOCIATED COST AS FACTOR. 11,844

TOTAL ASSOCIATED COST AS BOTH. 23,718

DIRECTLY ALIGNED SAFETY PROGRAMS. . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . . 224, 312

FIGURE B-14. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: ATC-OTHER (68*G9)



TOTAL ASSOCIATED FATALITIES 268

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 29
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 6

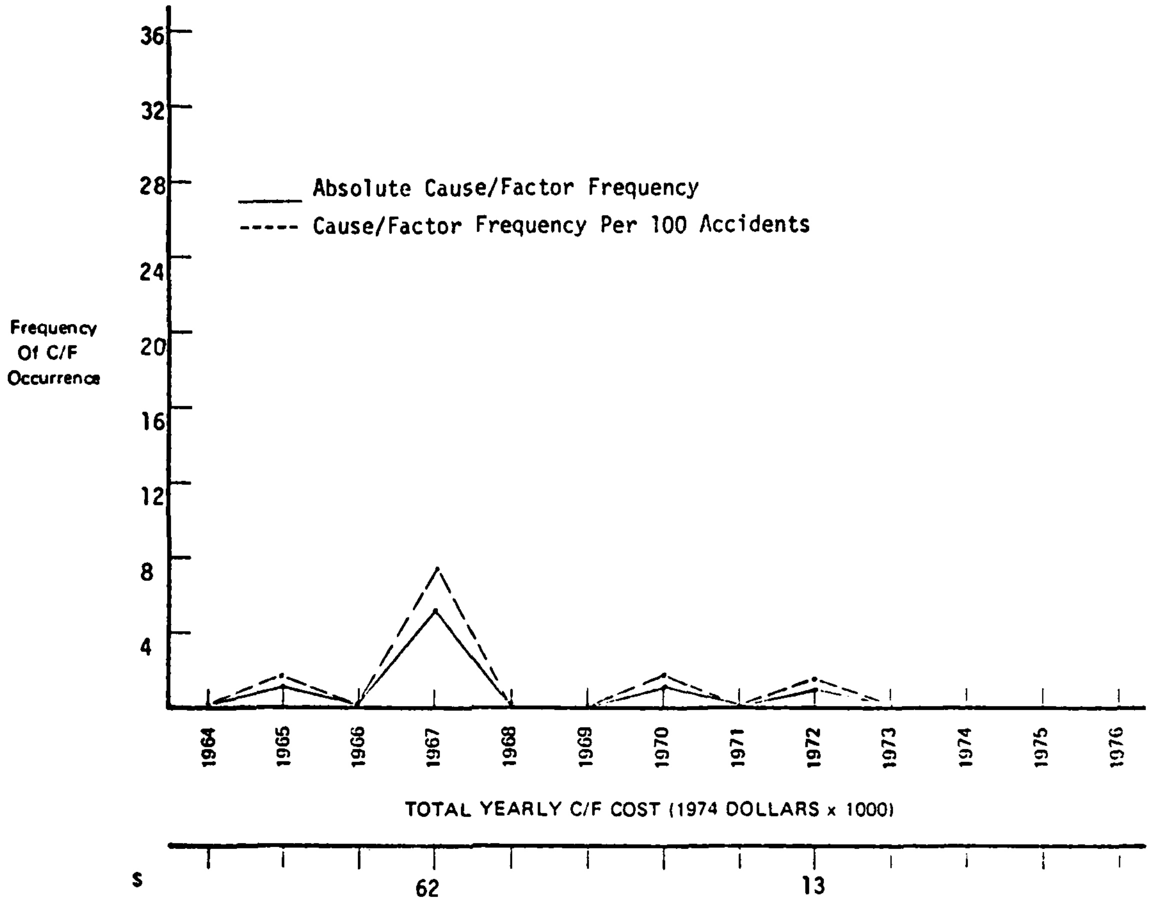
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 35

TOTAL ASSOCIATED COST AS CAUSE 41,174
TOTAL ASSOCIATED COST AS FACTOR 120

TOTAL ASSOCIATED COST AS BOTH 41,294

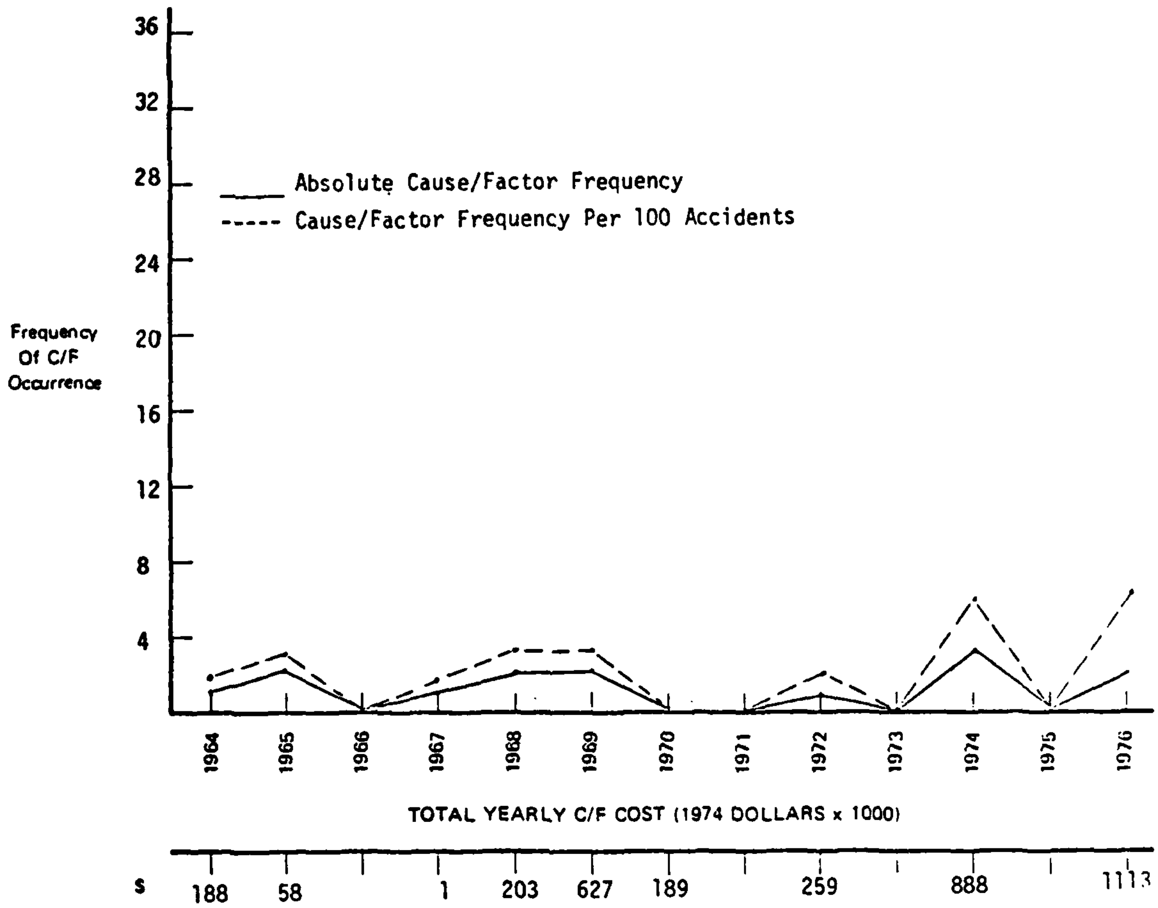
DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . 202, 206, 223

FIGURE B-15. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-PILOT OF OTHER AIRCRAFT (68*KO)



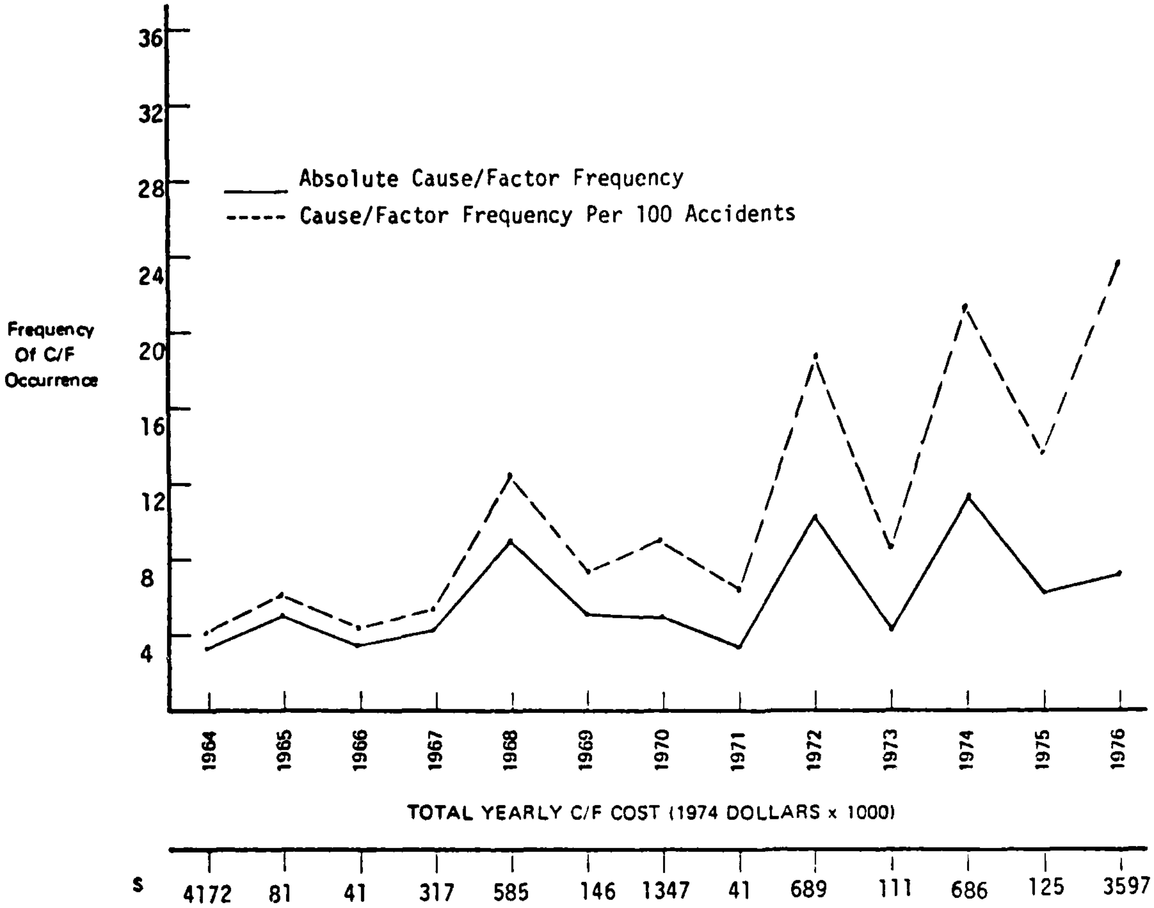
TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE	7
TOTAL ACCIDENTS ASSOCIATED AS FACTOR	1
TOTAL ACCIDENTS ASSOCIATED AS BOTH	8
TOTAL ASSOCIATED COST AS CAUSE	62
TOTAL ASSOCIATED COST AS FACTOR	13
TOTAL ASSOCIATED COST AS BOTH	75
DIRECTLY ALIGNED SAFETY PROGRAMS. . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	419, 422

FIGURE B-16. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-GROUND SIGNALMAN (68*K1)



TOTAL ASSOCIATED FATALITIES	6
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	13
TOTAL ACCIDENTS ASSOCIATED AS FACTOR. .	2
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . .	15
TOTAL ASSOCIATED COST AS CAUSE	3,451
TOTAL ASSOCIATED COST AS FACTOR	75
TOTAL ASSOCIATED COST AS BOTH	3,526
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	419

FIGURE B-17. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-GROUND CREW (68*K3)



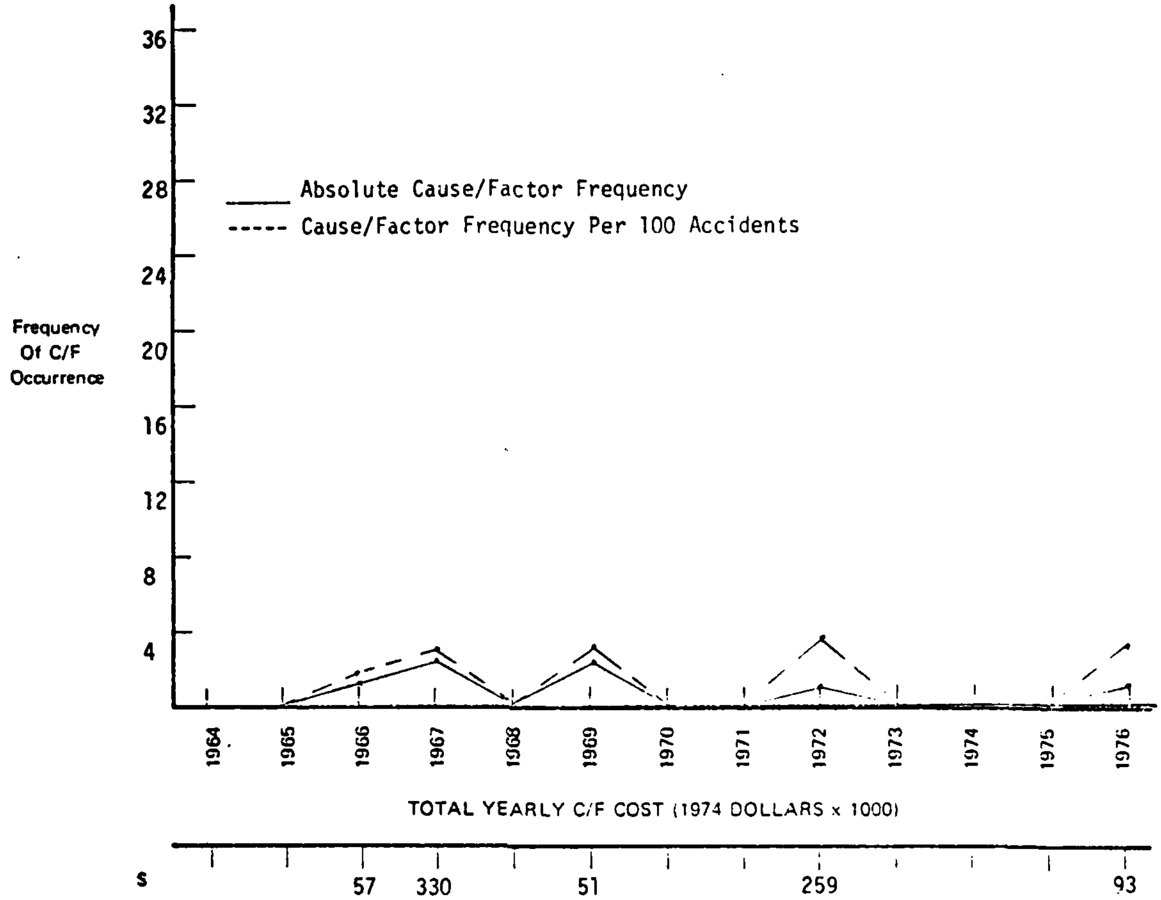
TOTAL ASSOCIATED FATALITIES 46

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 70
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 5
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 75

TOTAL ASSOCIATED COST AS CAUSE. 11,864
TOTAL ASSOCIATED COST AS FACTOR 74
TOTAL ASSOCIATED COST AS BOTH 11,938

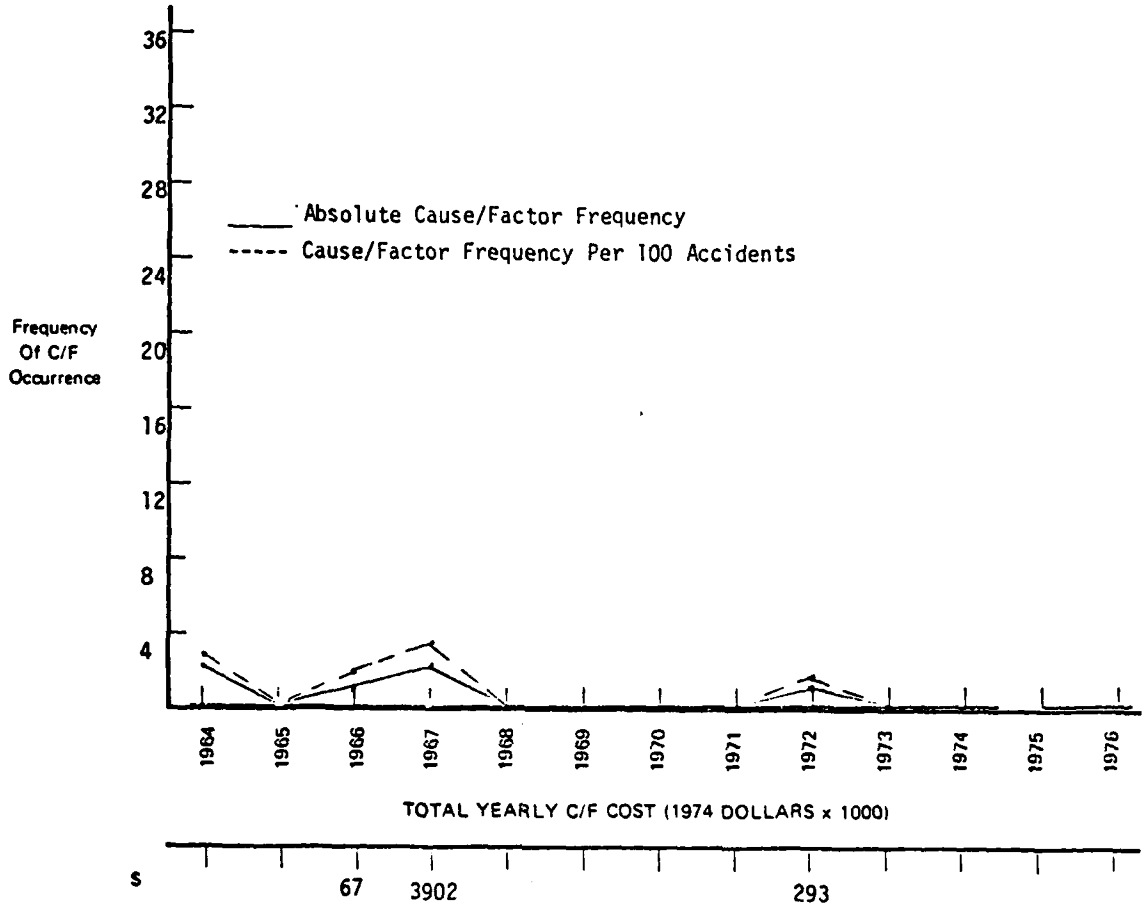
DIRECTLY ALIGNED SAFETY PROGRAMS . . . 307
INDIRECTLY ALIGNED SAFETY PROGRAMS . . 401

FIGURE B-18. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PERSONNEL-PASSENGER (68*K4)



TOTAL ASSOCIATED FATALITIES	2
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	1
TOTAL ACCIDENTS ASSOCIATED AS BOTH . .	7
TOTAL ASSOCIATED COST AS CAUSE	733
TOTAL ASSOCIATED COST AS FACTOR	57
TOTAL ASSOCIATED COST AS BOTH	790
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	None

FIGURE B-19. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: MISC. PERSONNEL-OTHER (68*KO)



TOTAL ASSOCIATED FATALITIES 38

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . -

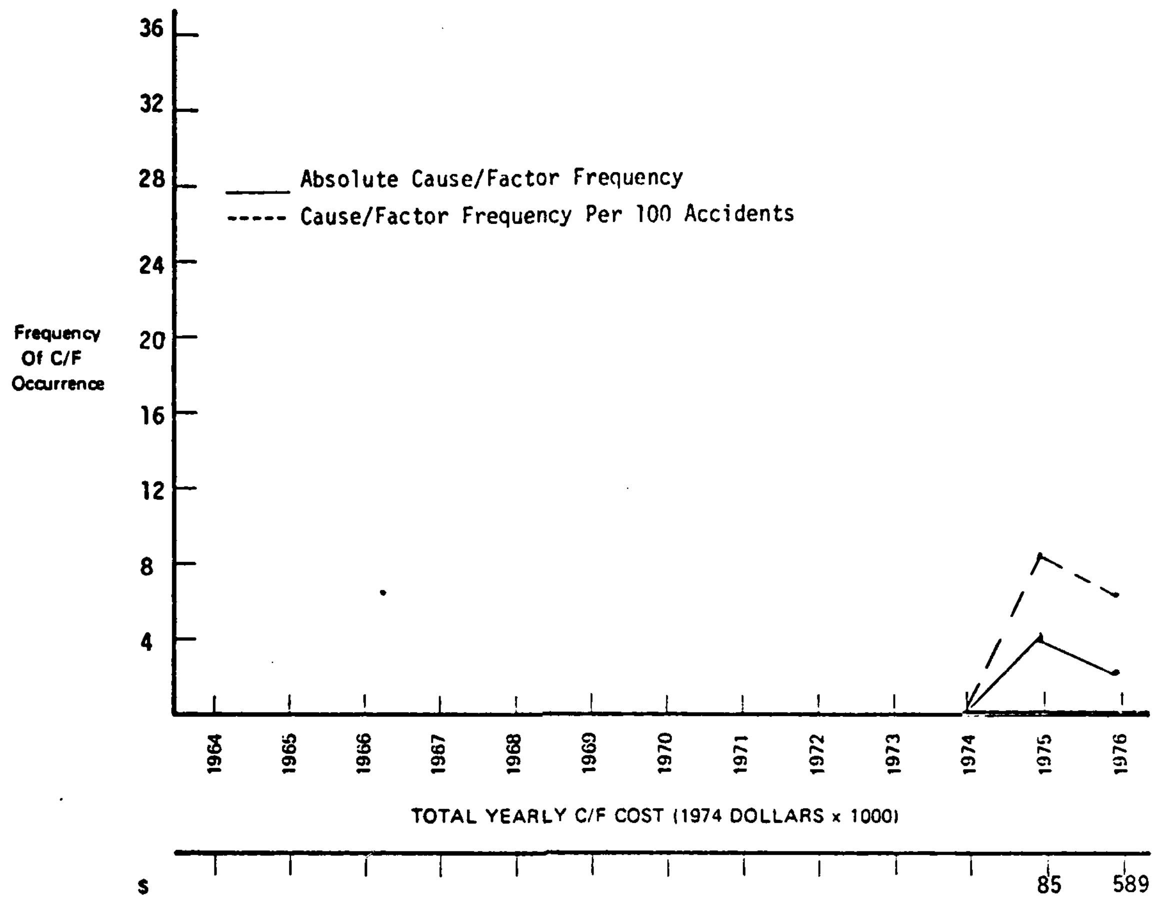
TOTAL ACCIDENTS ASSOCIATED AS BOTH 6

TOTAL ASSOCIATED COST AS CAUSE 4,262
TOTAL ASSOCIATED COST AS FACTOR. . . . -

TOTAL ASSOCIATED COST AS BOTH. 4,262

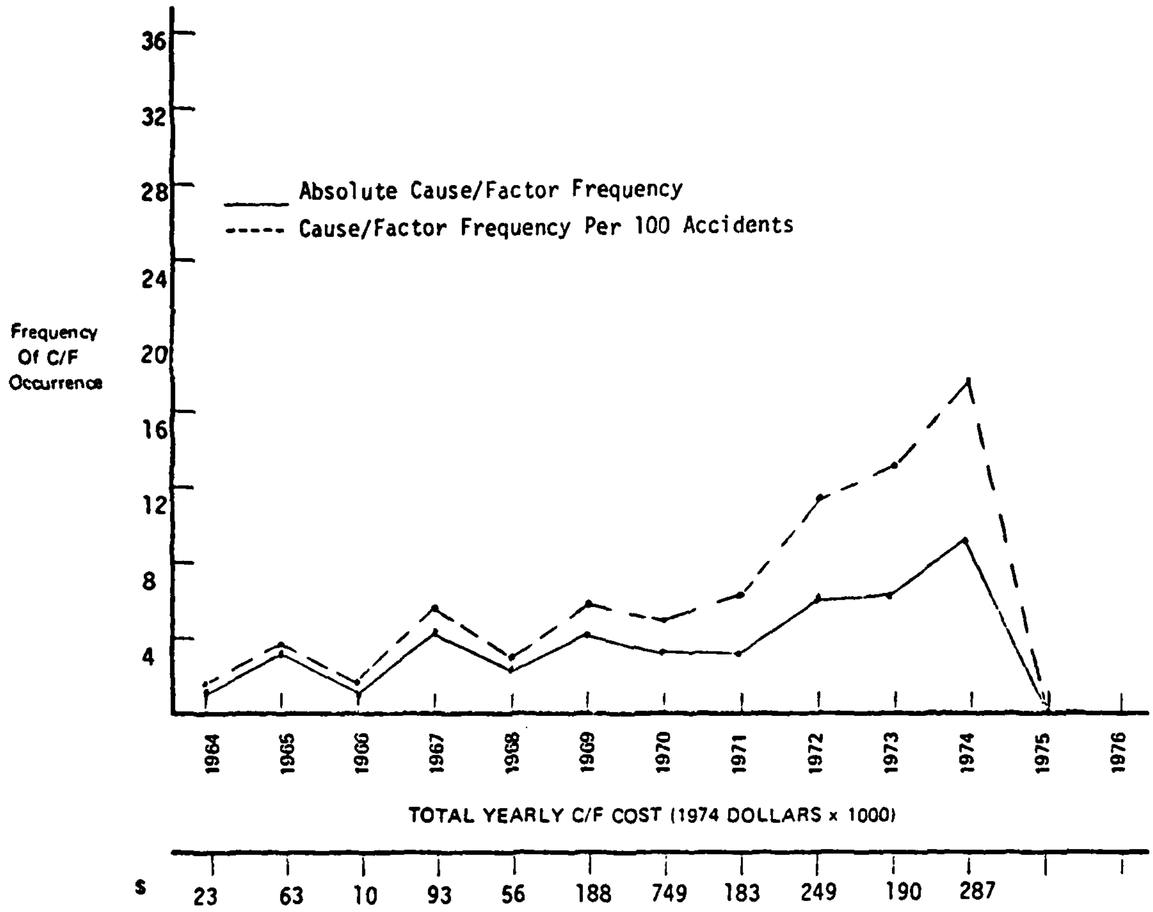
DIRECTLY ALIGNED SAFETY PROGRAMS. . . 305
INDIRECTLY ALIGNED SAFETY PROGRAMS . . 308, 602

FIGURE B-20. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: PRODUCTION/DESIGN PERSONNEL—OTHER (68*J0)



TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	-
TOTAL ACCIDENTS ASSOCIATED AS BOTH . .	6
TOTAL ASSOCIATED COST AS CAUSE	674
TOTAL ASSOCIATED COST AS FACTOR	-
TOTAL ASSOCIATED COST AS BOTH	674
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	none
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	Same as 68*R-code was changed 1974

FIGURE B-21. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: FLIGHT ATTENDENT (68*RO)



TOTAL ASSOCIATED FATALITIES 0

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 40
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 2

TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 42

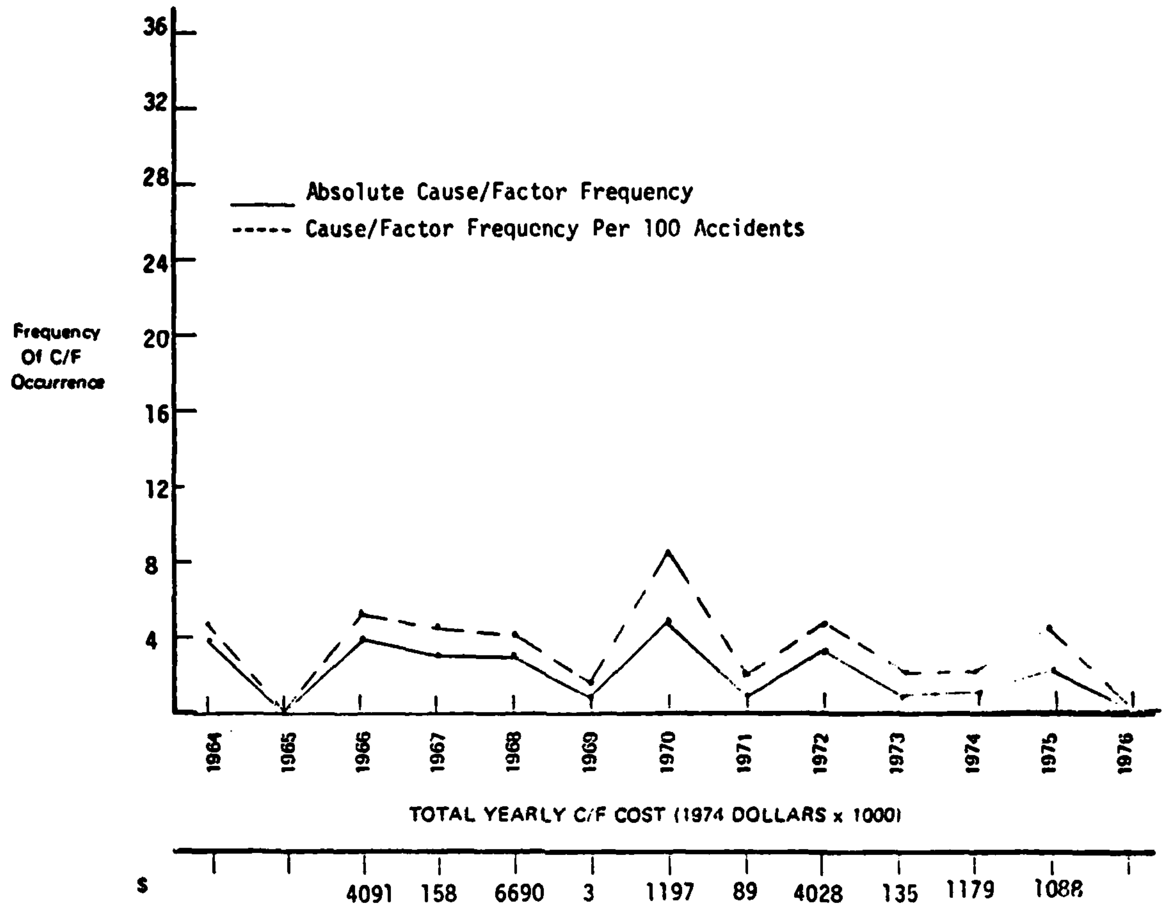
TOTAL ASSOCIATED COST AS CAUSE 1,943
TOTAL ASSOCIATED COST AS FACTOR 148

TOTAL ASSOCIATED COST AS BOTH 2,091

DIRECTLY ALIGNED SAFETY PROGRAMS 307
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .401, 419

FIGURE B-22. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: FLIGHT PERSONNEL (68*R)

70*00 Includes CL, BY, CP, BF, DS, CN, D9, DB, AY,
AE, CK, 01, DO, AA, BH



TOTAL ASSOCIATED FATALITIES 324

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 21
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 7

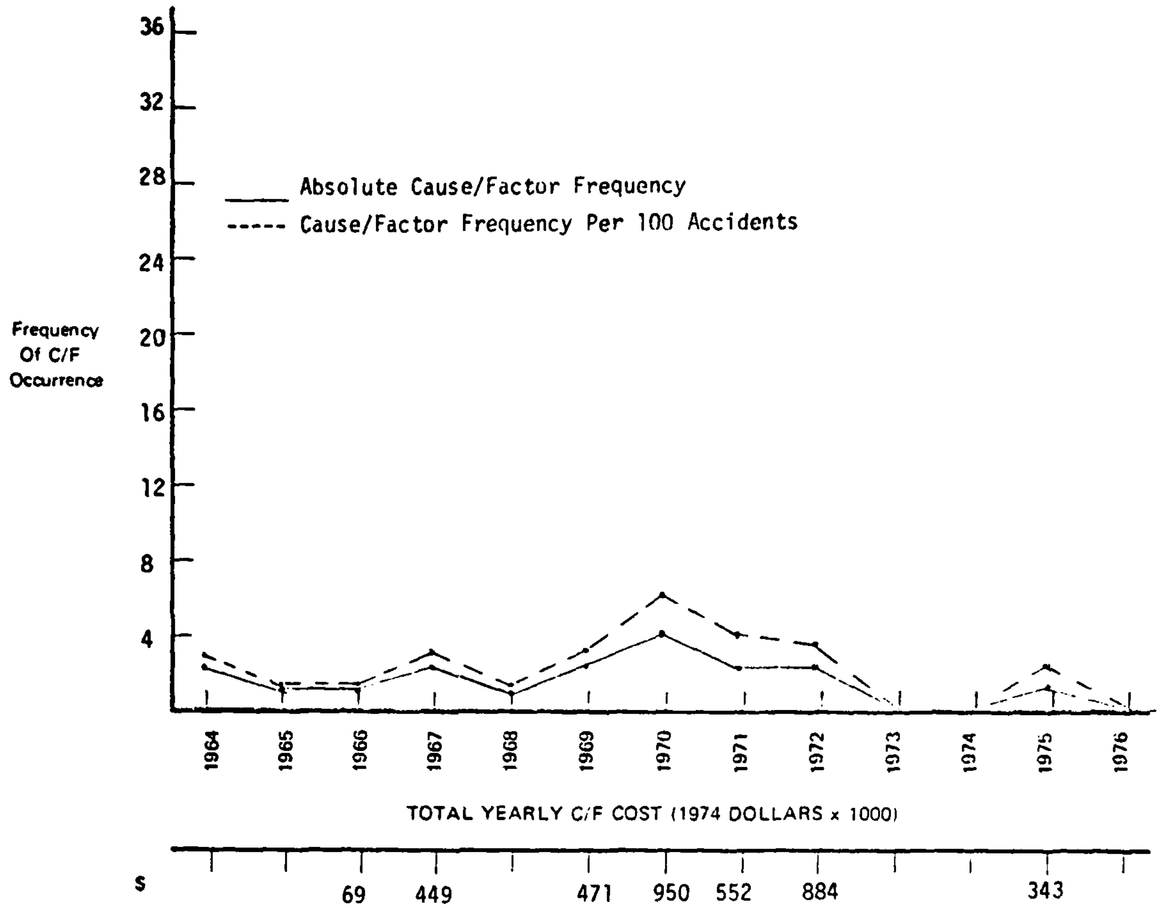
TOTAL ACCIDENTS ASSOCIATED AS BOTH 28

TOTAL ASSOCIATED COST AS CAUSE 15,308
TOTAL ASSOCIATED COST AS FACTOR 3,350

TOTAL ASSOCIATED COST AS BOTH 18,658

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS 305, 308, 402, 404, 409, 411

FIGURE B-23. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: AIRFRAME-MISC. (70*00)



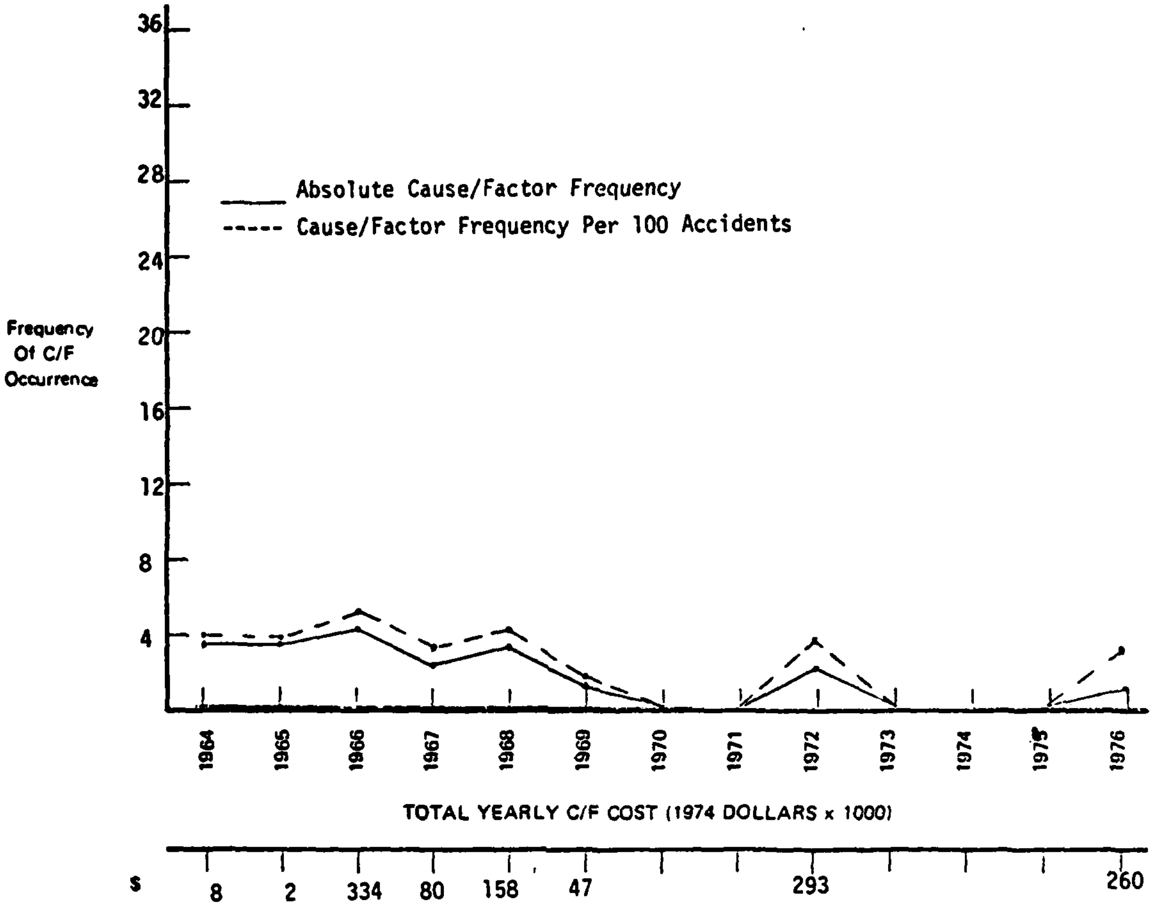
TOTAL ASSOCIATED FATALITIES 0

TOTAL ACCIDENTS ASSOCIATED AS CAUSE 18
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 0
TOTAL ACCIDENTS ASSOCIATED AS BOTH. 18

TOTAL ASSOCIATED COST AS CAUSE 3,718
TOTAL ASSOCIATED COST AS FACTOR . . . . . -
TOTAL ASSOCIATED COST AS BOTH 3,718

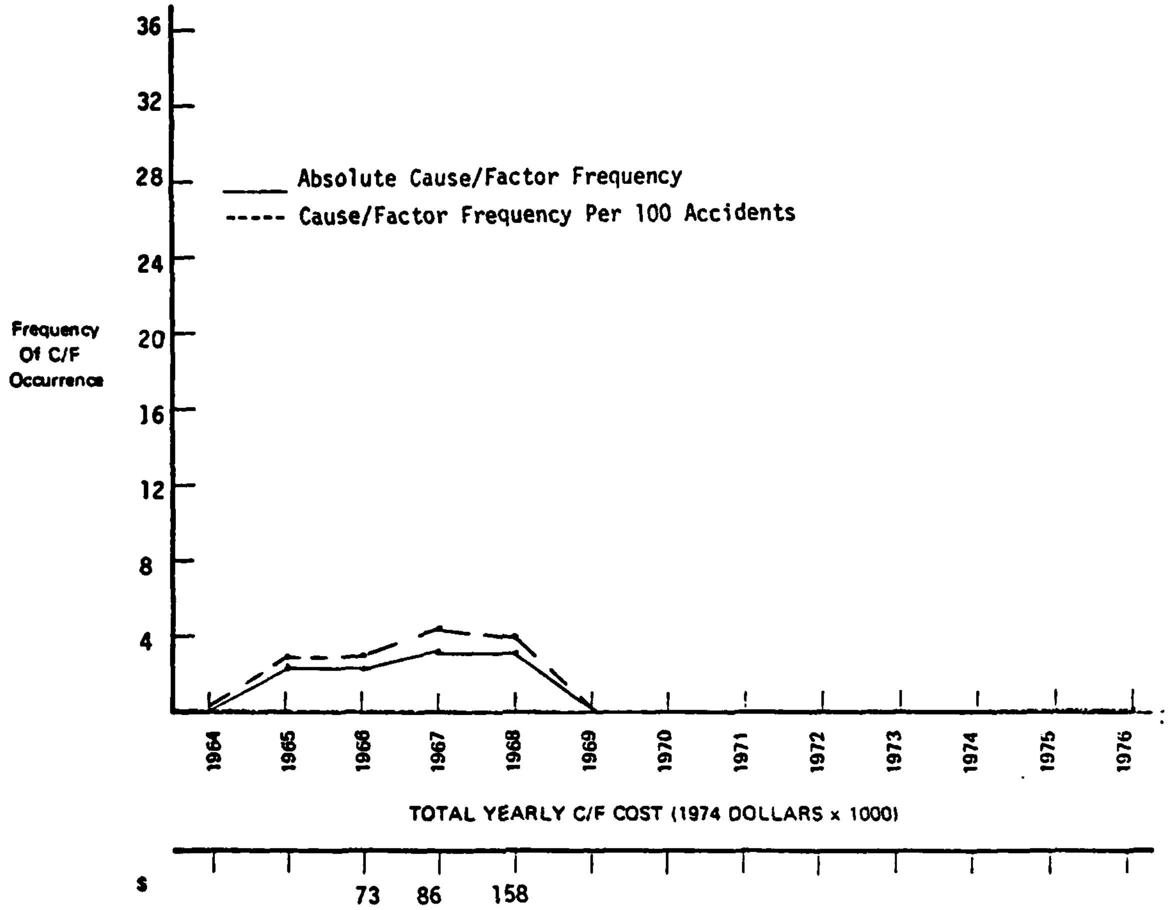
DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS 305, 308, 402, 406

FIGURE B-24. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-MAIN GEAR SHOCKS (70*CA)



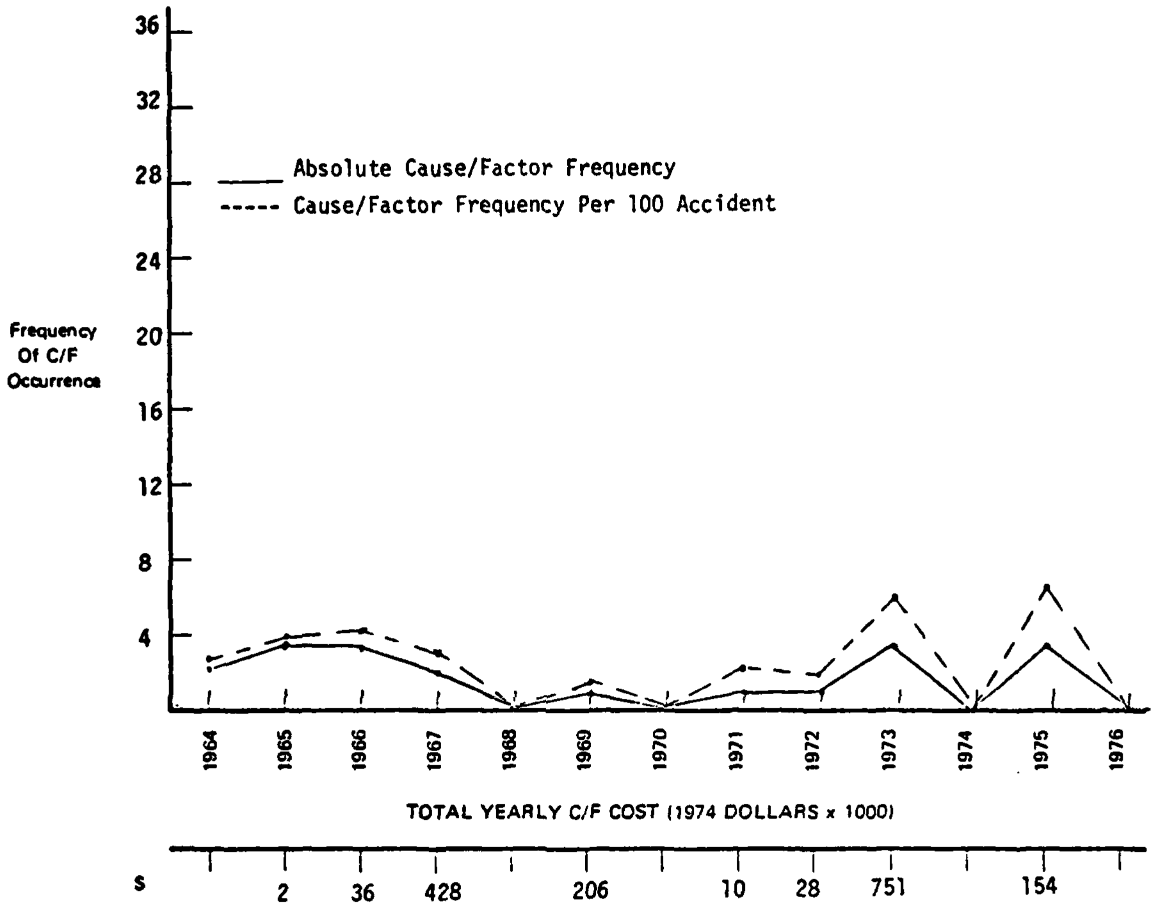
TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	18
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	1
TOTAL ACCIDENTS ASSOCIATED AS BOTH . .	19
TOTAL ASSOCIATED COST AS CAUSE	1,182
TOTAL ASSOCIATED COST AS FACTOR	-
TOTAL ASSOCIATED COST AS BOTH	1,182
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	Same as 70*CA

FIGURE B-25. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-NORMAL EXTENSION (70*CB)



TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	10
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	0
TOTAL ACCIDENTS ASSOCIATED AS BOTH . .	10
TOTAL ASSOCIATED COST AS CAUSE	317
TOTAL ASSOCIATED COST AS FACTOR	-
TOTAL ASSOCIATED COST AS BOTH	317
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	Same as 70*CA

FIGURE B-26. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-EMERGENCY EXTENSION (70*CC)



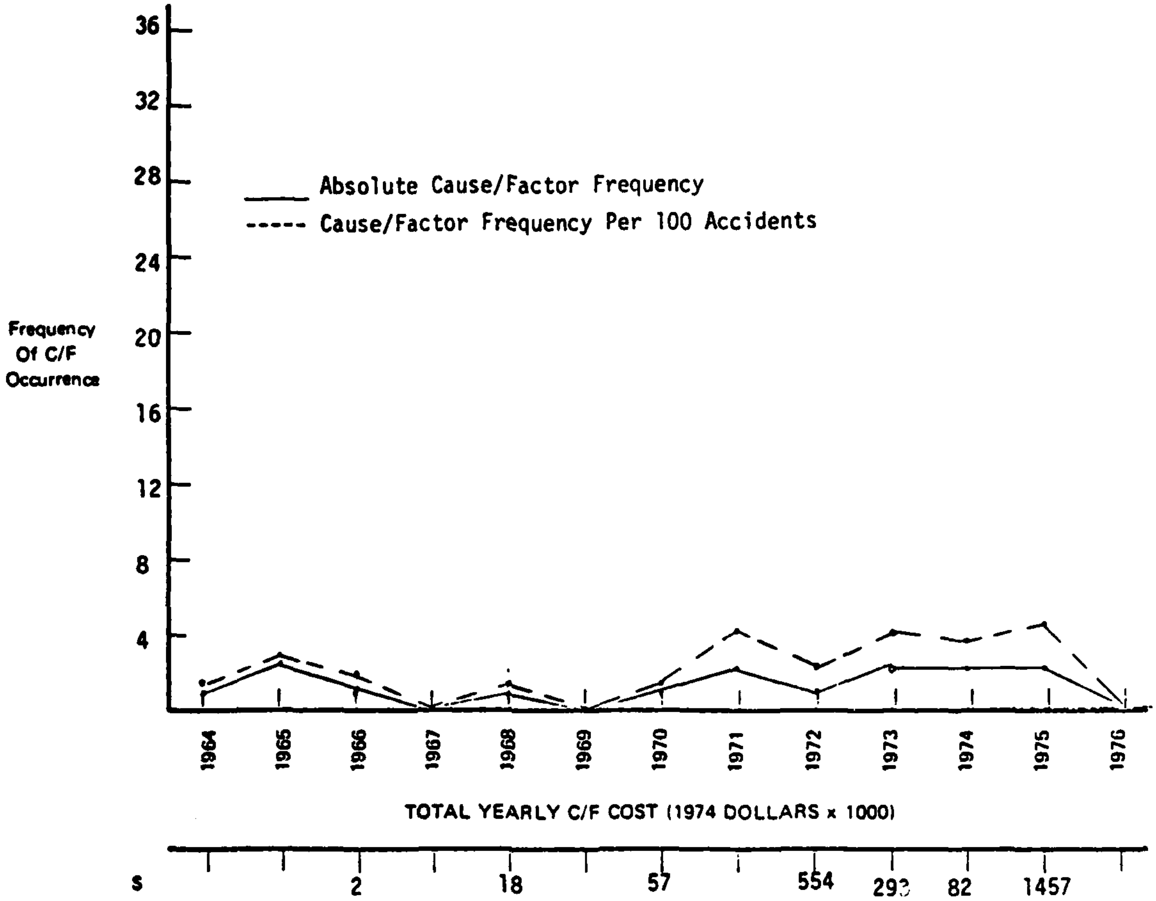
TOTAL ASSOCIATED FATALITIES 0

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 19
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 0
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 19

TOTAL ASSOCIATED COST AS CAUSE 1,615
TOTAL ASSOCIATED COST AS FACTOR . . . . . -
TOTAL ASSOCIATED COST AS BOTH 1,615

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . Same as 70*CA

FIGURE B-27. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-NOSEWHEEL (70*CE)



TOTAL ASSOCIATED FATALITIES 0

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 13
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 0

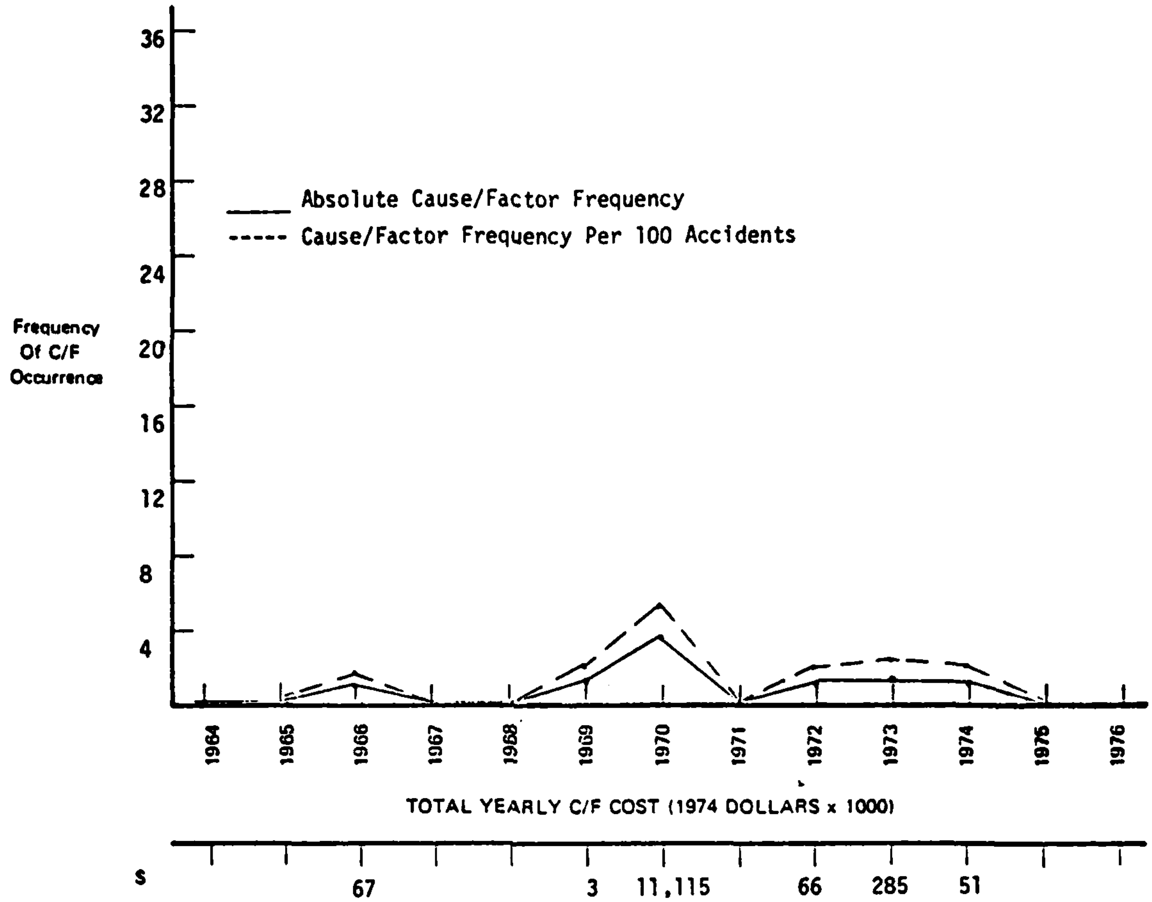
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 13

TOTAL ASSOCIATED COST AS CAUSE 2,463
TOTAL ASSOCIATED COST AS FACTOR . . . . . -

TOTAL ASSOCIATED COST AS BOTH 2,463

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . Same as 70*CA

FIGURE B-28. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-WHEELS/TIRES/AXLES (70*CF)



TOTAL ASSOCIATED FATALITIES 47

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 7
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 1

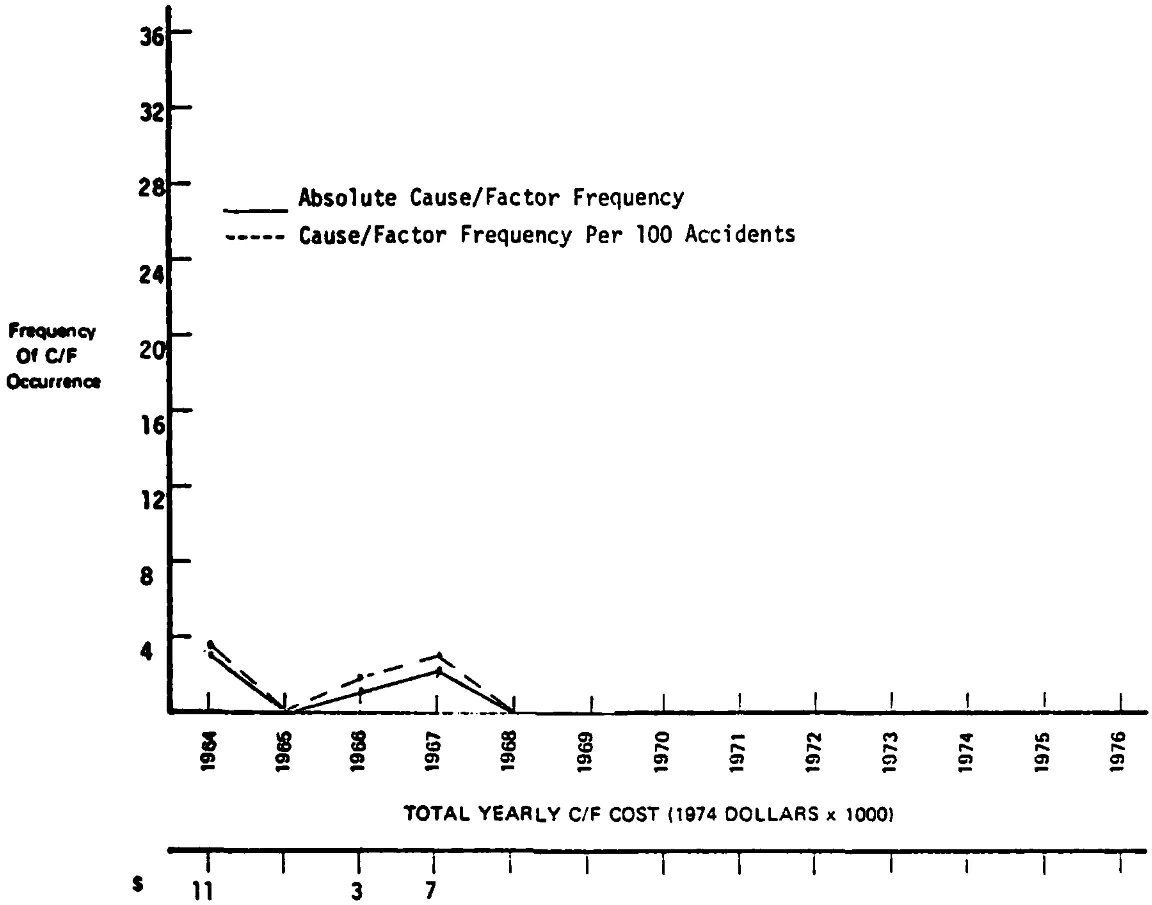
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 8

TOTAL ASSOCIATED COST AS CAUSE 11,574
TOTAL ASSOCIATED COST AS FACTOR. 13

TOTAL ASSOCIATED COST AS BOTH 11,587

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . Same as 70*CA

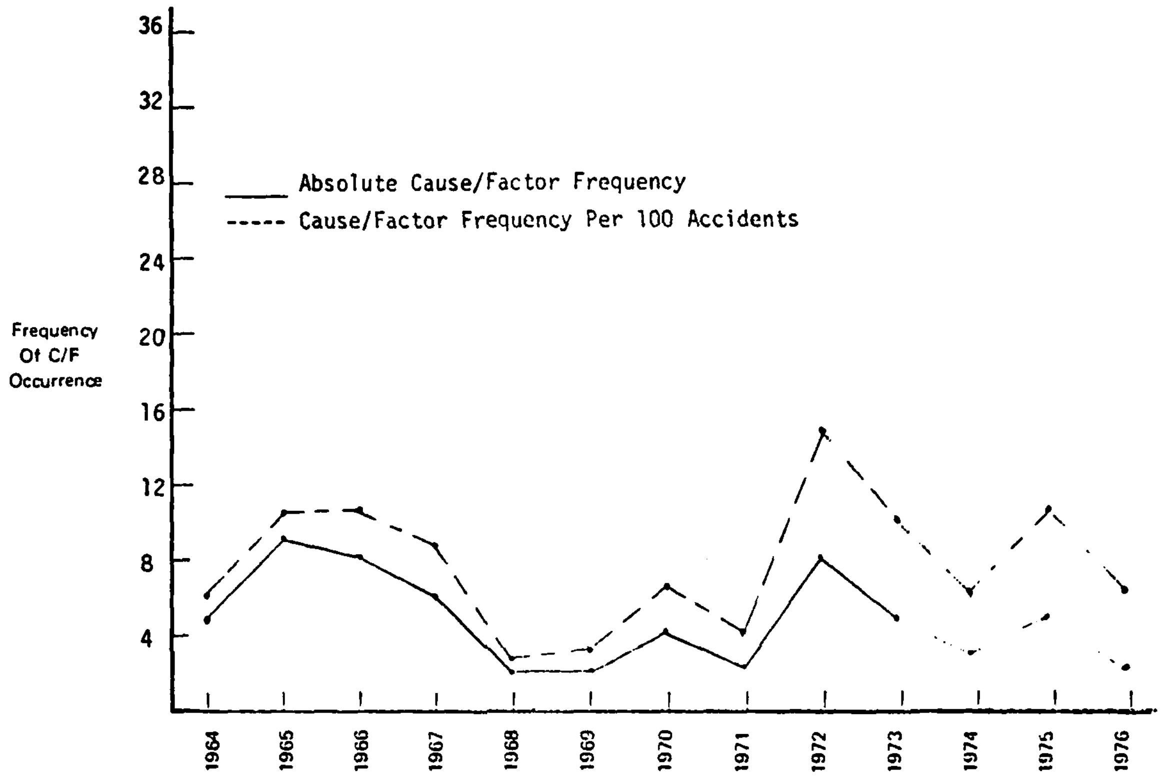
FIGURE B-29. CAUSE/FACTOR FR.)UENCY AND COST SUMMARY: LANDING GEAR-BRAKING SYS. (70*CJ)



TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR .	-
TOTAL ACCIDENTS ASSOCIATED AS BOTH . .	6
TOTAL ASSOCIATED COST AS CAUSE	21
TOTAL ASSOCIATED COST AS FACTOR	-
TOTAL ASSOCIATED COST AS BOTH	21
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	Same as 70*CA

FIGURE B-30. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: LANDING GEAR-LOCK MECHANISM (70*CM)

74*00 includes AC, KB, PG, KA, FA, Y8, FY, PM, AY, PH, ZY, CA, PE, AA, MY, AB, SY, PJ, AE, FD, KD, WO, DB, FC, MI, CB, MK, Y4, SE, CY, PF, MD, KC, 56, PY, UO, IO, MF

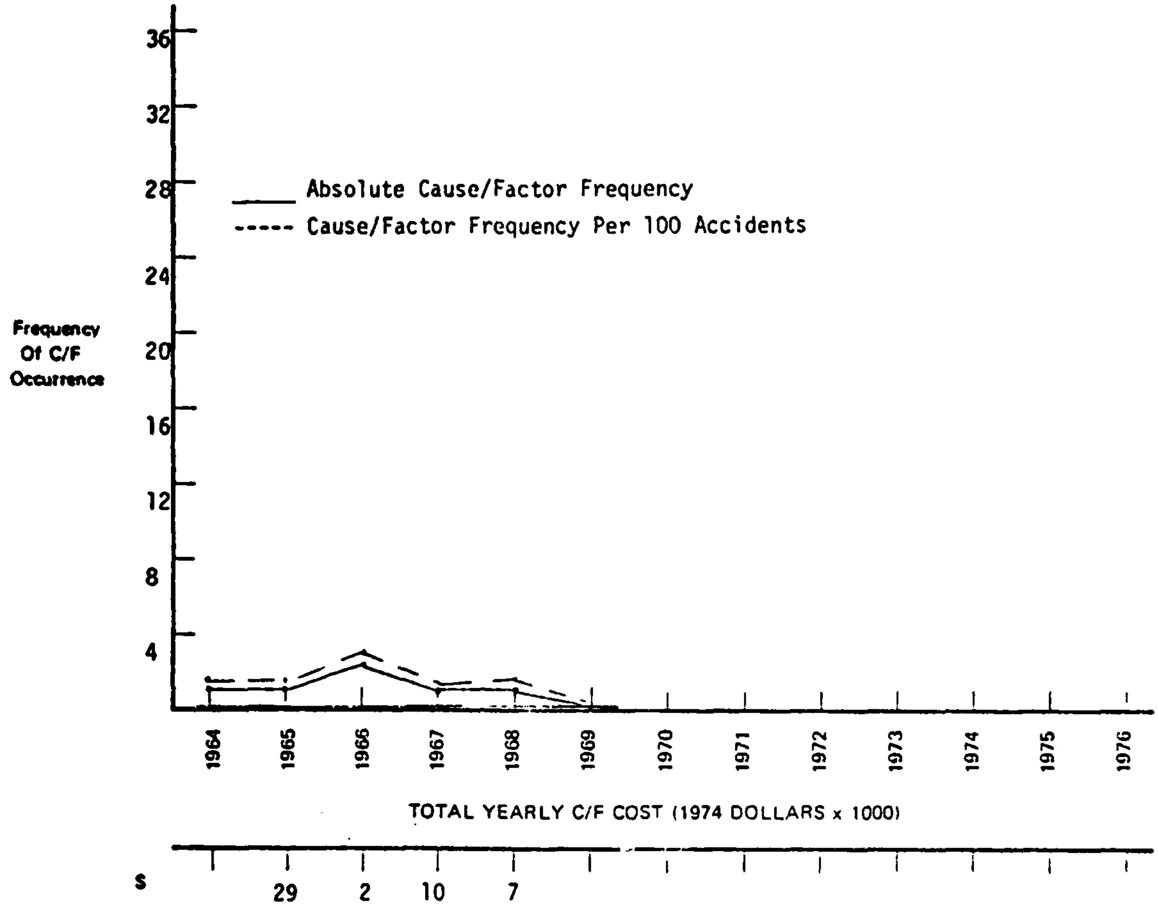


TOTAL YEARLY C/F COST (1974 DOLLARS x 1000)

$	9357	566	497	7514	499	906	492	868	2390	472	795	170	1284

TOTAL ASSOCIATED FATALITIES	153
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . .	60
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . .	1
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . .	61
TOTAL ASSOCIATED COST AS CAUSE	25,656
TOTAL ASSOCIATED COST AS FACTOR	154
TOTAL ASSOCIATED COST AS BOTH	25,810
DIRECTLY ALIGNED SAFETY PROGRAMS	None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .	305, 308, 402, 407, 408, 409, 411

FIGURE B-31. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: POWERPLANTS-MISC. (74*00)



TOTAL ASSOCIATED FATALITIES. 0

TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . 6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . 6

TOTAL ASSOCIATED COST AS CAUSE 48
TOTAL ASSOCIATED COST AS FACTOR. . . . -
TOTAL ASSOCIATED COST AS BOTH. 48

DIRECTLY ALIGNED SAFETY PROGRAMS. . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . 308, 407

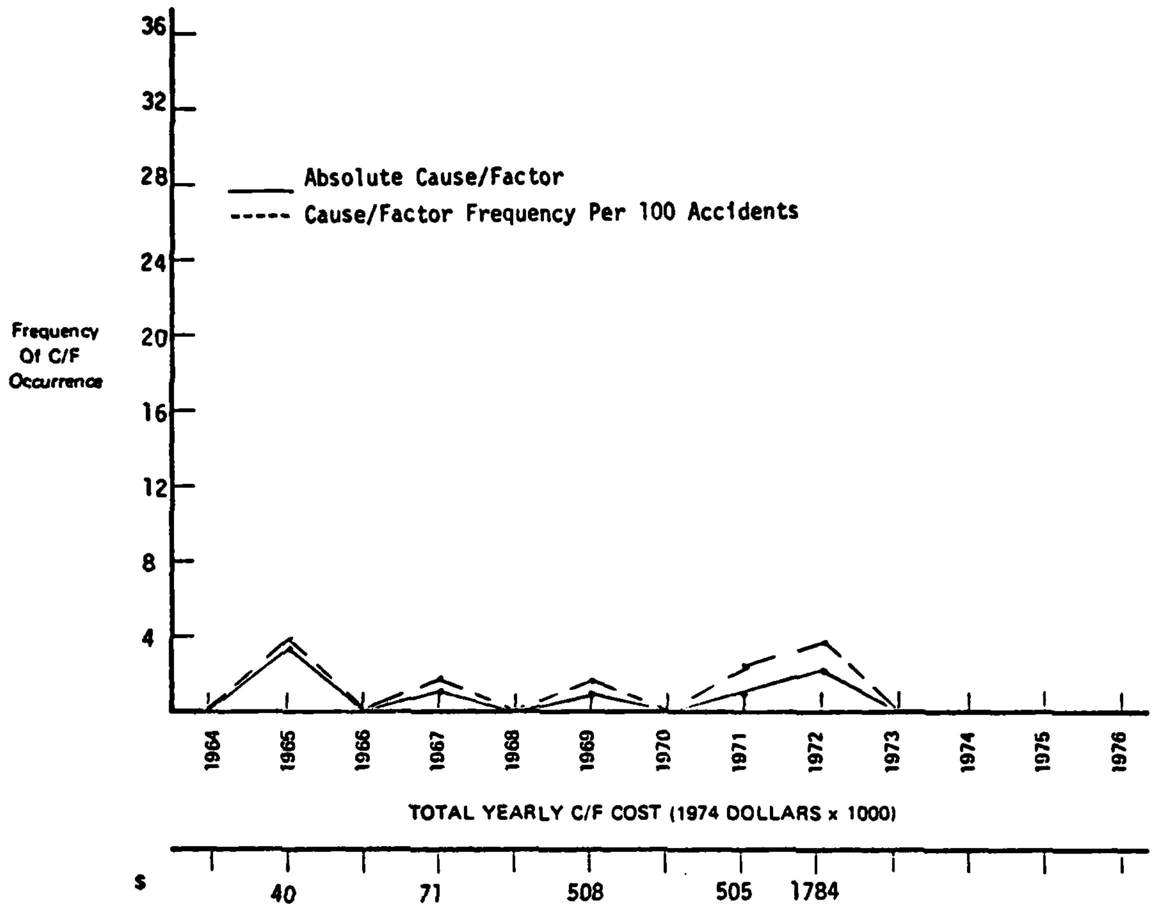
FIGURE 32. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: ENGINE-CYLINDER ASSEMBLY (74*AD)

AD-A085 347 BATTELLE COLUMBUS LABS OH F/G 13/12
EVALUATION OF SAFETY PROGRAMS WITH RESPECT TO THE CAUSES OF AIR--ETC(U)
JAN 80 T M CONNOR, C W HAMILTON DOT-FA77WA-4072

UNCLASSIFIED FAA-ASP -80-1 NL

3 OF 3
AD
A085 347

END
DATE
FILMED
7-80
DTIC



TOTAL ASSOCIATED FATALITIES. 0

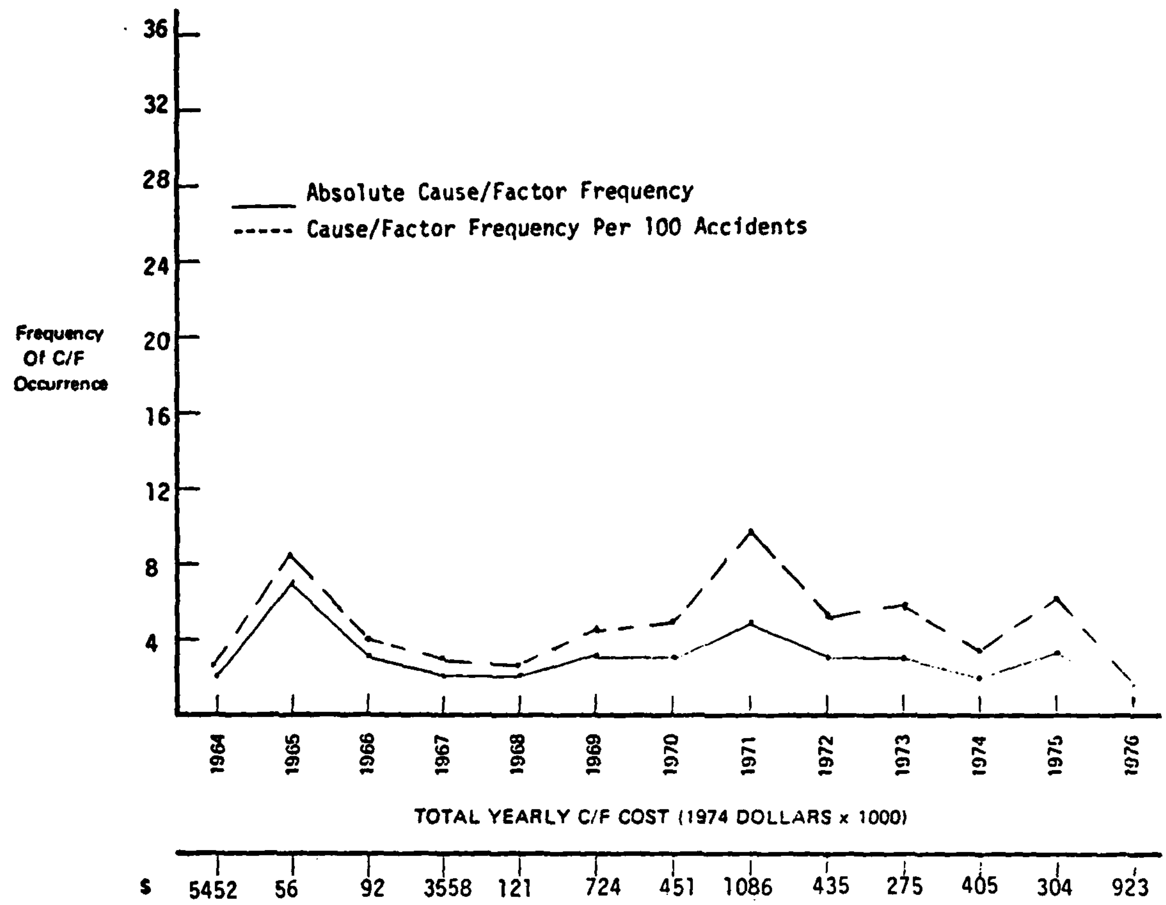
TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . 8
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 8

TOTAL ASSOCIATED COST AS CAUSE 3,069
TOTAL ASSOCIATED COST AS FACTOR. . . . . -
TOTAL ASSOCIATED COST AS BOTH. 3,069

DIRECTLY ALIGNED SAFETY PROGRAMS . . .None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .Same as 74*AD

FIGURE B-33. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: COMPRESSOR ASSEMBLY-ROTOR (74*ME)

75*00 includes AY, AJ, GA, CE, CN, DB, B1, BB, CI, CY, BF, AL, CC, JY, FY, EY, AA, BY, IC, CK, JA, EC



TOTAL ASSOCIATED FATALITIES 147

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 30
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 9

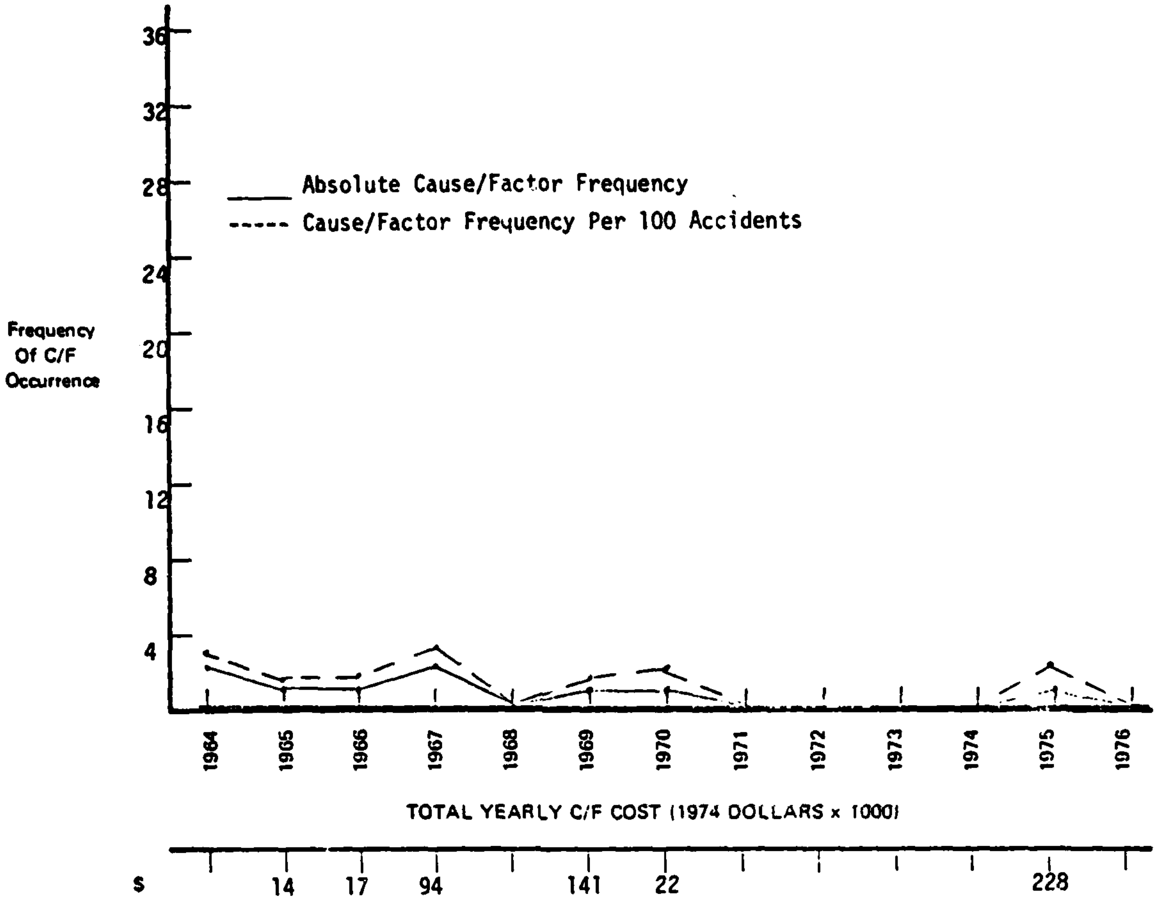
TOTAL ACCIDENTS ASSOCIATED AS BOTH. . . . 39

TOTAL ASSOCIATED COST AS CAUSE. 12,969
TOTAL ASSOCIATED COST AS FACTOR 913

TOTAL ASSOCIATED COST AS BOTH 13,882

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . 305, 308, 402, 409, 411

FIGURE B-34. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: SYSTEMS-MISC. (75*00)



TOTAL ASSOCIATED FATALITIES. 5

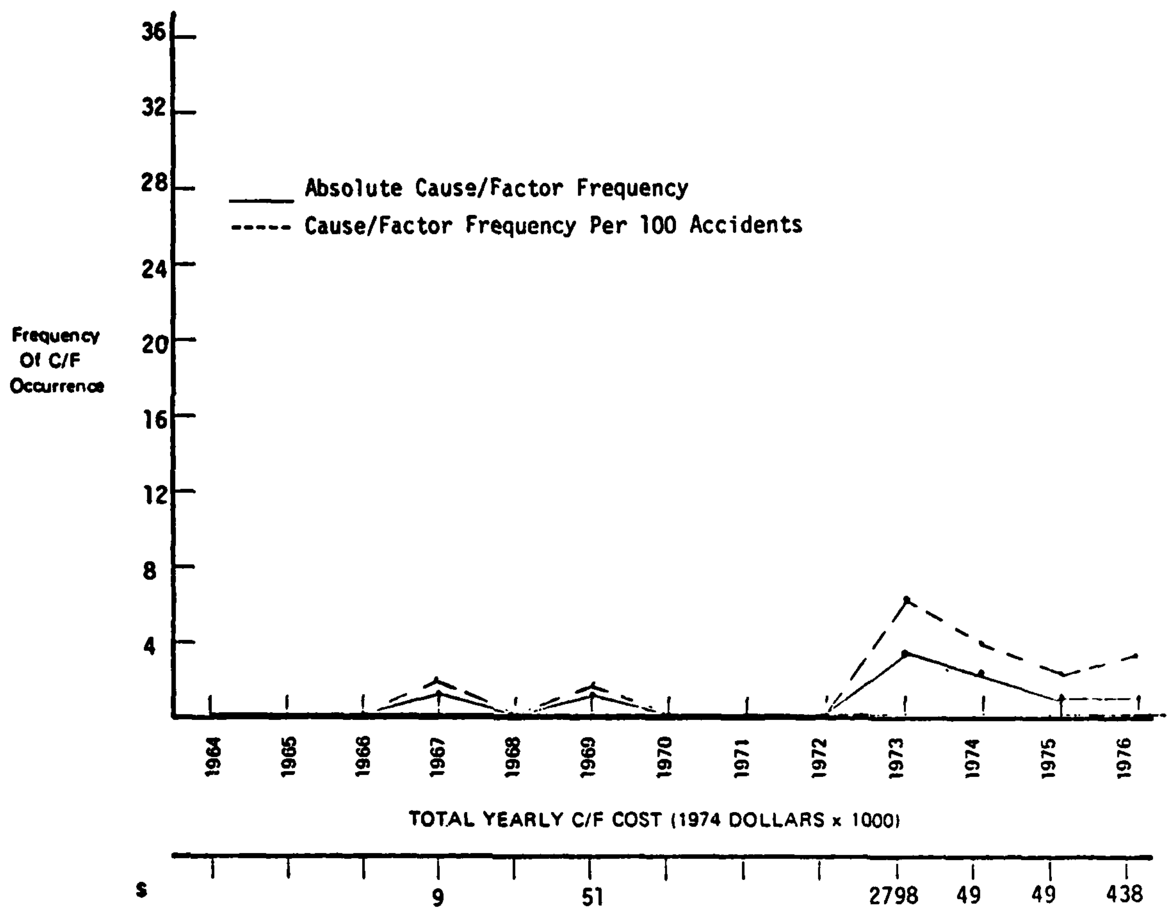
TOTAL ACCIDENTS ASSOCIATED AS CAUSE. . . 7
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 2
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 9

TOTAL ASSOCIATED COST AS CAUSE 375
TOTAL ASSOCIATED COST AS FACTOR 141
TOTAL ASSOCIATED COST AS BOTH 516

DIRECTLY ALIGNED SAFETY PROGRAMS . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . . 308, 402, 406

FIGURE 35. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: HYDRAULIC SYS-RESERVOIR LINES (75*BD)

76*00 includes CY, AA, AY



TOTAL ASSOCIATED FATALITIES 88

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 4
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 5

TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 9

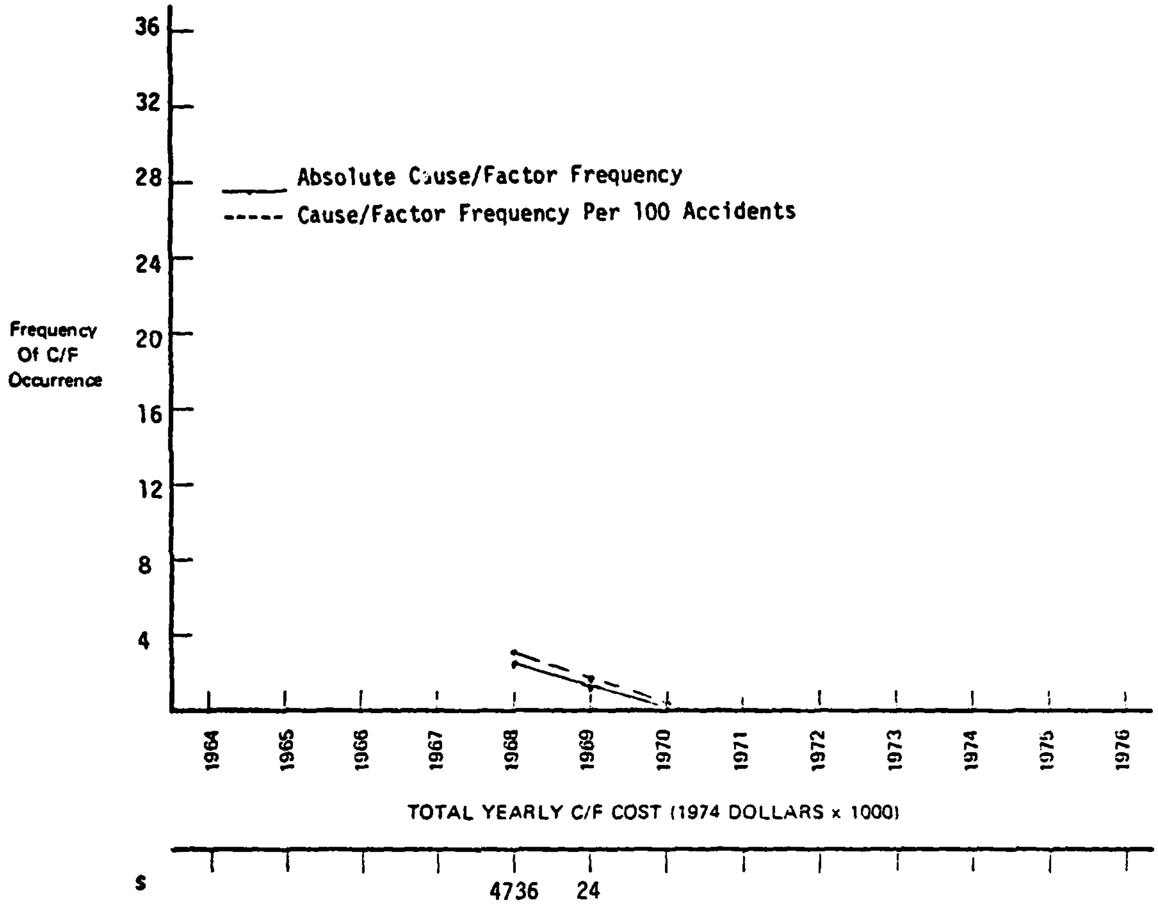
TOTAL ASSOCIATED COST AS CAUSE 537
TOTAL ASSOCIATED COST AS FACTOR 2,857

TOTAL ASSOCIATED COST AS BOTH 3,394

DIRECTLY ALIGNED SAFETY PROGRAMS = None
INDIRECTLY ALIGNED SAFETY PROGRAMS = 305, 308, 402, 409, 411

FIGURE B-36. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: INSTRUMENTS/EQUIPMENT-MISC. (76*00)

78*00 includes AY, AB



TOTAL ASSOCIATED FATALITIES 44

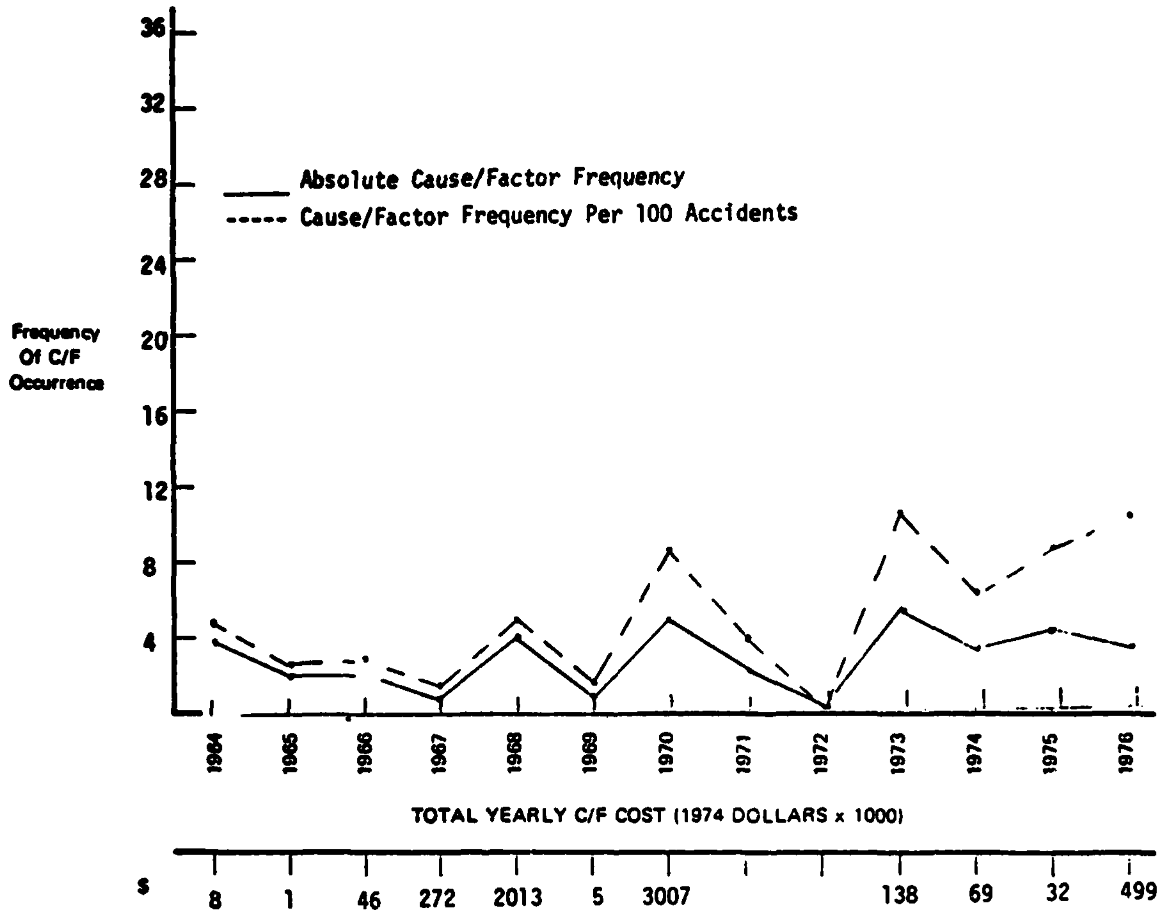
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 3
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 3

TOTAL ASSOCIATED COST AS CAUSE. 4,760
TOTAL ASSOCIATED COST AS FACTOR . . . . . -
TOTAL ASSOCIATED COST AS BOTH 4,760

DIRECTLY ALIGNED SAFETY PROGRAMS . . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . 305, 308, 402, 405, 409, 411

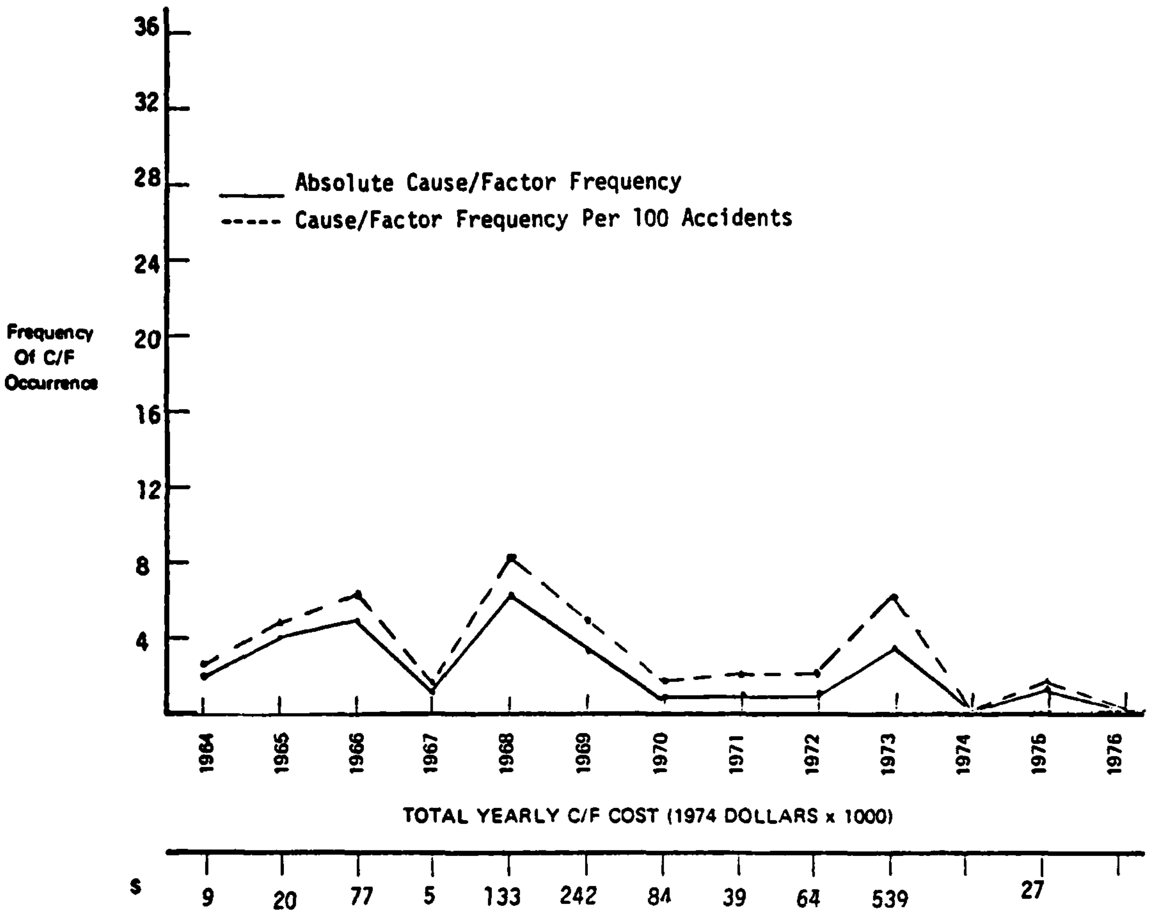
FIGURE B-37. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: HELICOPTER-MISC. (78*00)

80*00 includes BB, BY, BK, BD, A4, BP, A2, CO, AO, BF



TOTAL ASSOCIATED FATALITIES	80
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . .	18
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . .	19
TOTAL ACCIDENTS ASSOCIATED AS BOTH	37
TOTAL ASSOCIATED COST AS CAUSE	3,002
TOTAL ASSOCIATED COST AS FACTOR	3,089
TOTAL ASSOCIATED COST AS BOTH	6,091
DIRECTLY ALIGNED SAFETY PROGRAMS	209
INDIRECTLY ALIGNED SAFETY PROGRAMS	115, 310, 312, 422 502, 504, 505

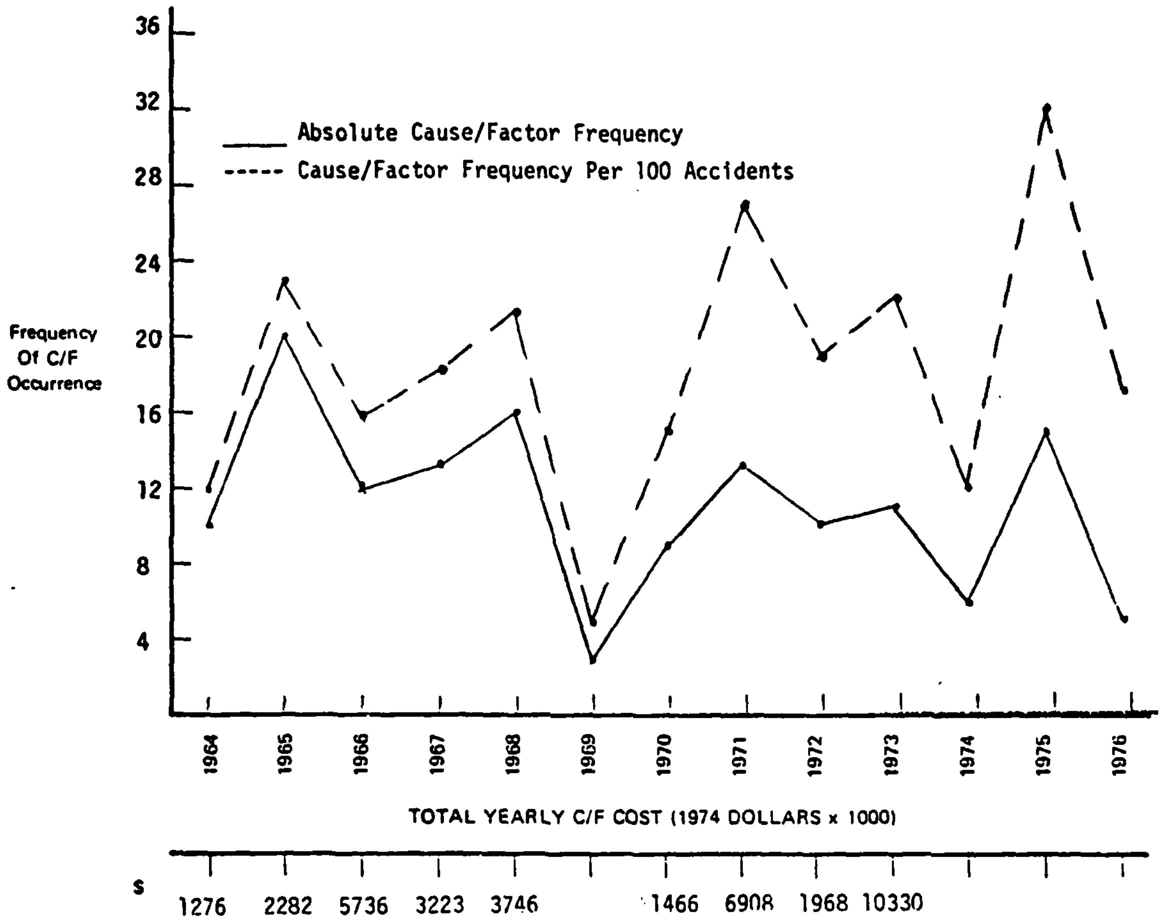
FIGURE B-38. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: AIRPORT/AIRWAYS, FACILITIES-MISC. (80*00)



TOTAL ASSOCIATED FATALITIES	0
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . .	9
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . .	19
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . .	28
TOTAL ASSOCIATED COST AS CAUSE	807
TOTAL ASSOCIATED COST AS FACTOR	432
TOTAL ASSOCIATED COST AS BOTH	1239
DIRECTLY ALIGNED SAFETY PROGRAMS . . .	117
INDIRECTLY ALIGNED SAFETY PROGRAMS . .	422

FIGURE B-39. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: AIRPORT-WET RUNWAY (80*BA)

82*00 includes A, M, Y, F, C, E, Q, I, D, J,
S, V, R



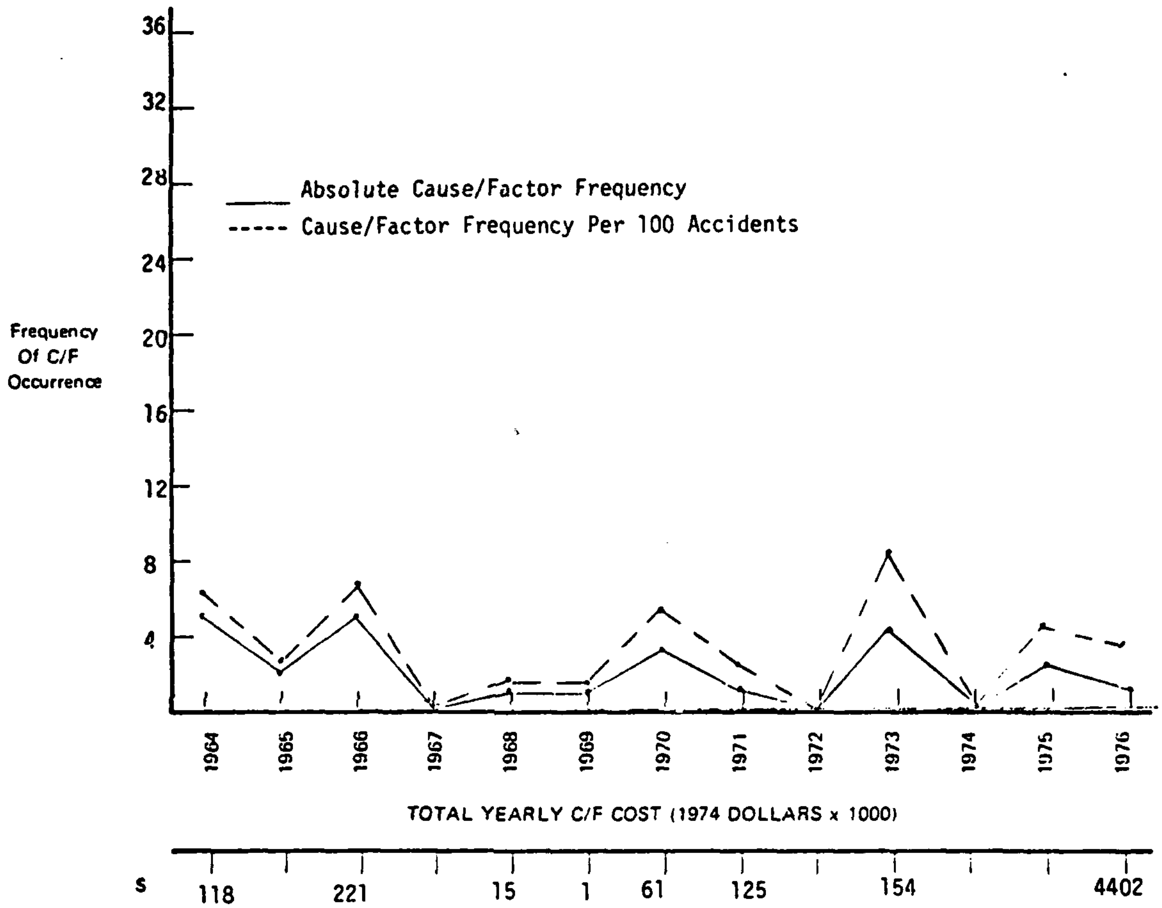
TOTAL ASSOCIATED FATALITIES 1,602

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 25
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 118
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 143

TOTAL ASSOCIATED COST AS CAUSE 26,640
TOTAL ASSOCIATED COST AS FACTOR 36,841
TOTAL ASSOCIATED COST AS BOTH 63,481

DIRECTLY ALIGNED SAFETY PROGRAMS 219
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .102, 103, 203, 207, 225, 301

FIGURE B-40. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-MISC. (82*00)



TOTAL ASSOCIATED FATALITIES. 48

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 7
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . 18

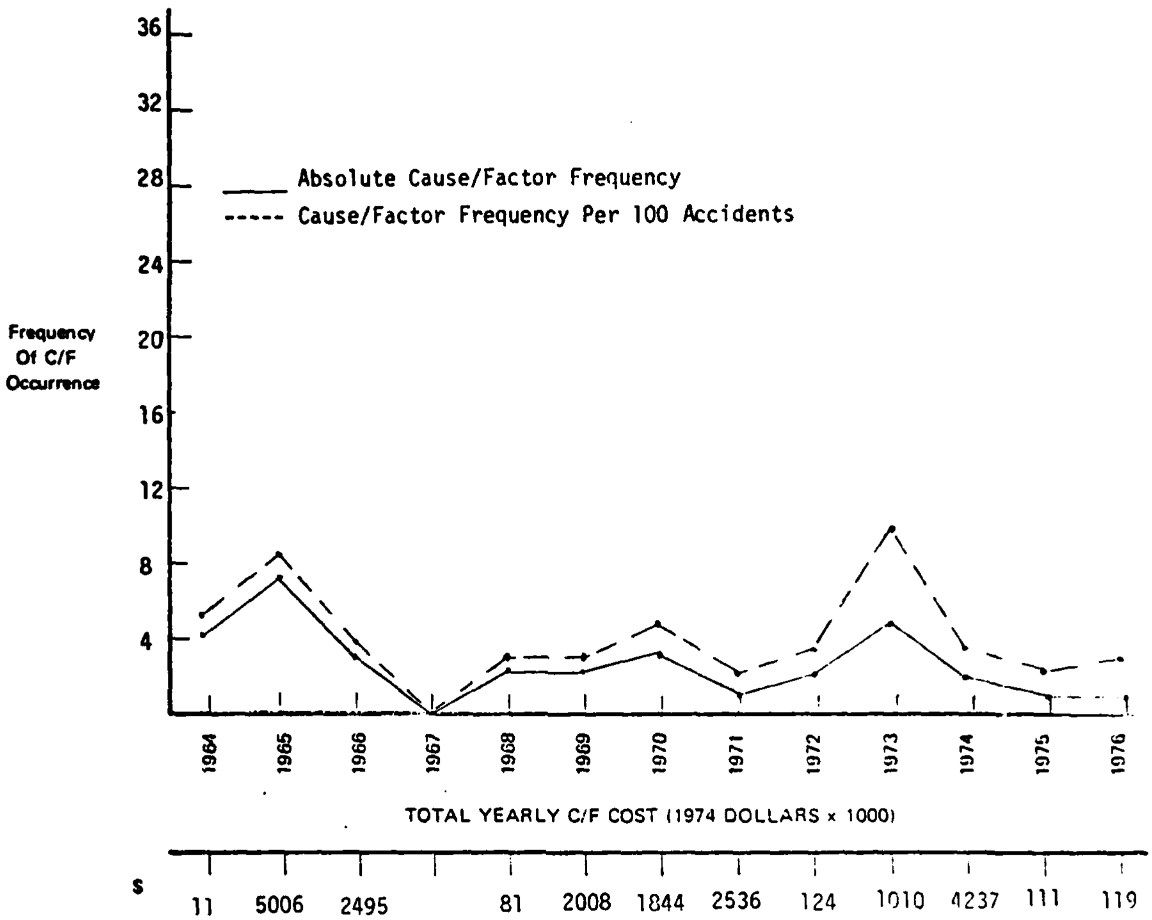
TOTAL ACCIDENTS ASSOCIATED AS BOTH 25

TOTAL ASSOCIATED COST AS CAUSE 4,663
TOTAL ASSOCIATED COST AS FACTOR 434

TOTAL ASSOCIATED COST AS BOTH 5,097

DIRECTLY ALIGNED SAFETY PROGRAMS . . . 216
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .102, 103

FIGURE B-41. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-RAIN (82*B)



TOTAL ASSOCIATED FATALITIES 465

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 6
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 27

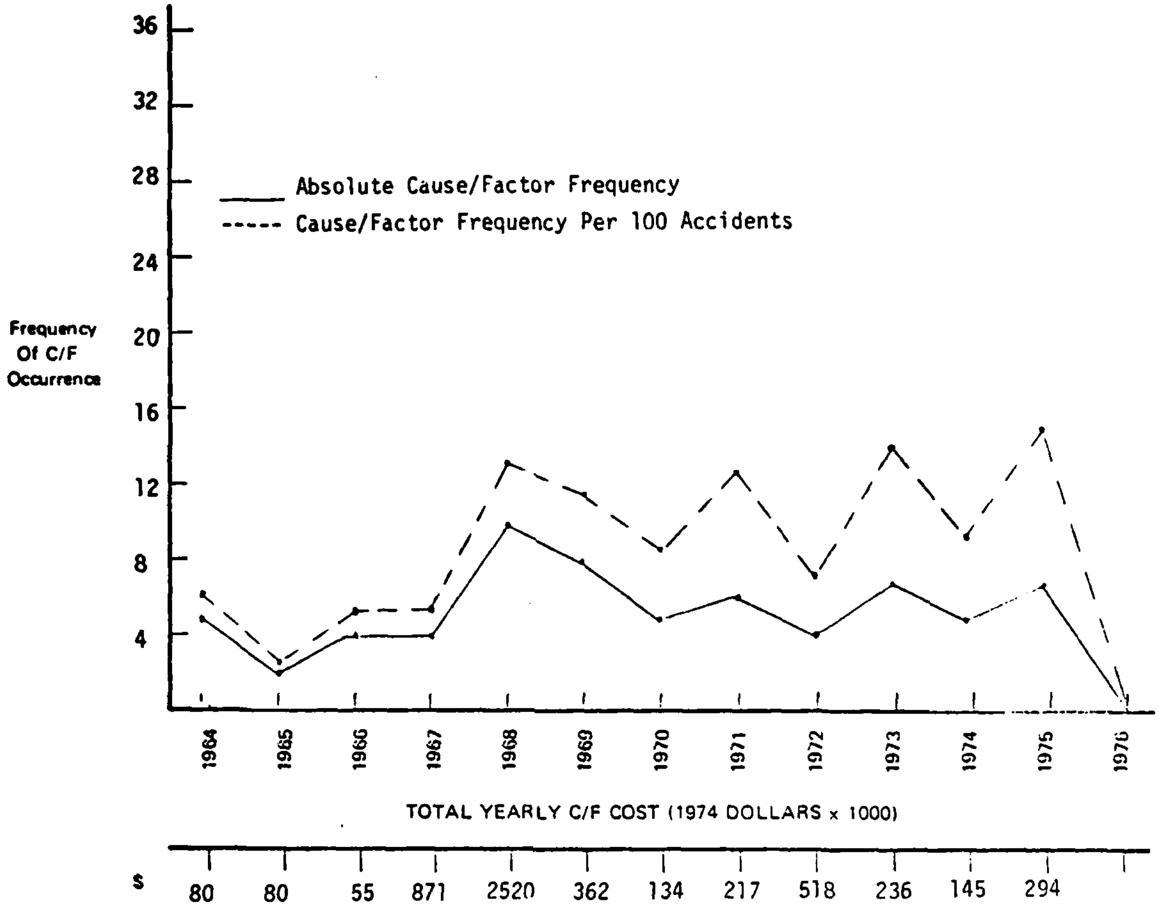
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 33

TOTAL ASSOCIATED COST AS CAUSE 7,652
TOTAL ASSOCIATED COST AS FACTOR 10,124

TOTAL ASSOCIATED COST AS BOTH 17,776

DIRECTLY ALIGNED SAFETY PROGRAMS. . . .None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . .None

FIGURE B-42. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-UNFAVORABLE WINDS (82*H)



TOTAL ASSOCIATED FATALITIES 39

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 63
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 4

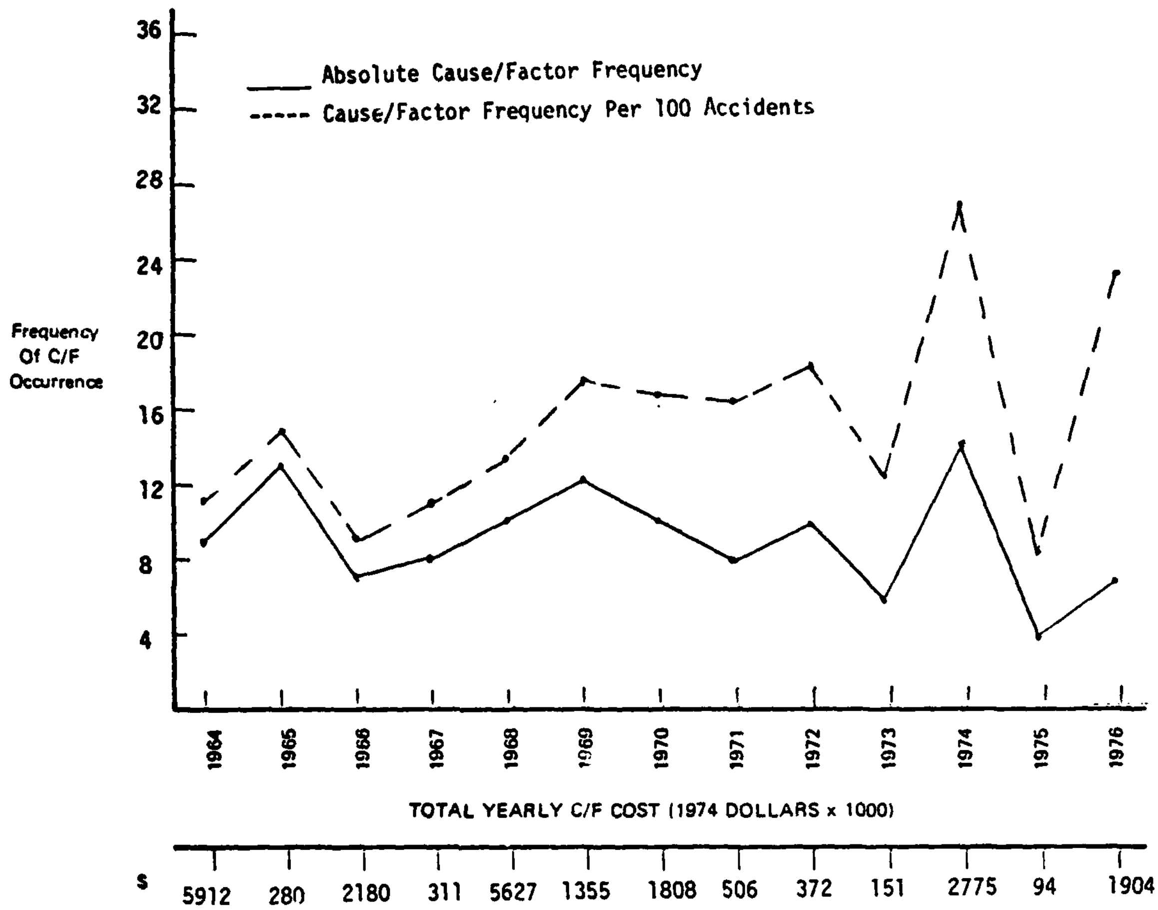
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 67

TOTAL ASSOCIATED COST AS CAUSE 5,489
TOTAL ASSOCIATED COST AS FACTOR 23

TOTAL ASSOCIATED COST AS BOTH 5,512

DIRECTLY ALIGNED SAFETY PROGRAMS . . . .None
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .None

FIGURE B-43. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-CLEAR AIR TURBULENCE (82*K)



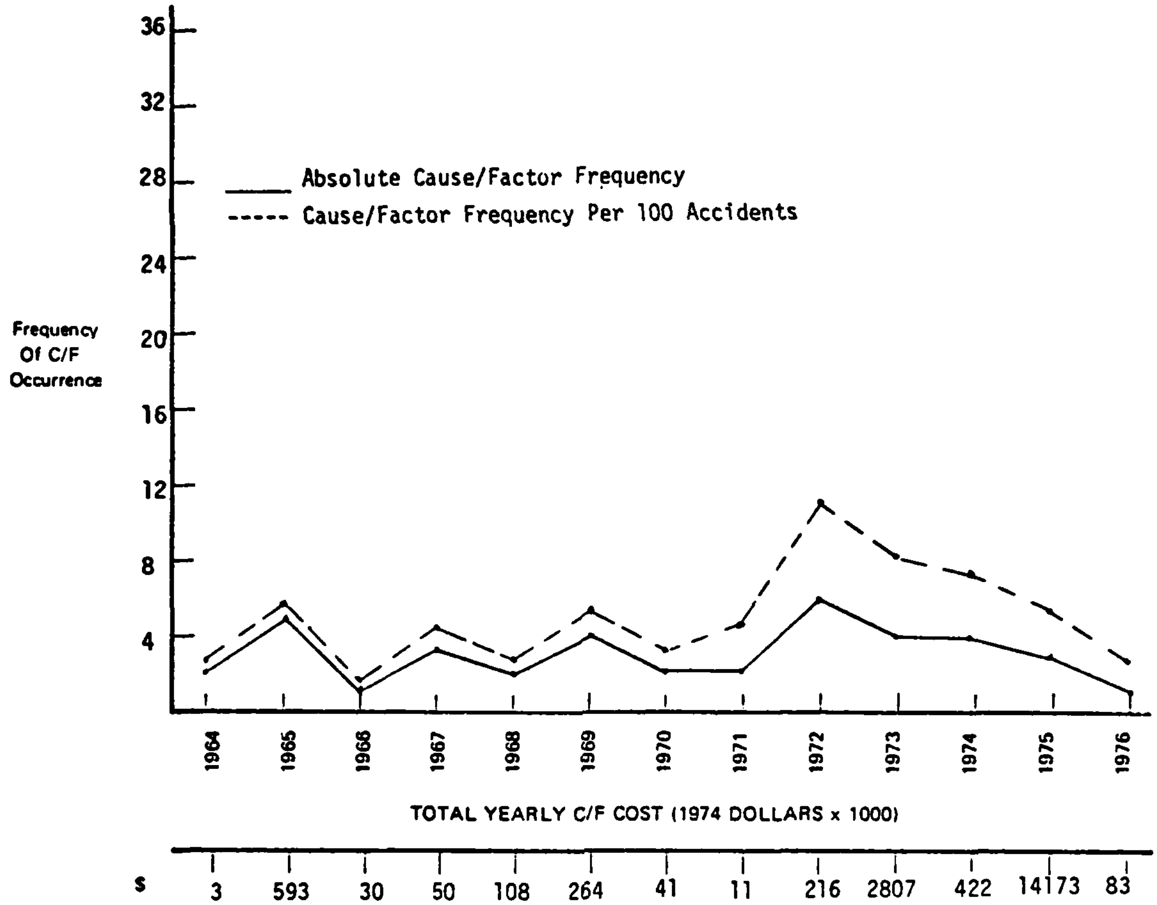
TOTAL ASSOCIATED FATALITIES 285

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 112
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 6
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 118

TOTAL ASSOCIATED COST AS CAUSE 20,941
TOTAL ASSOCIATED COST AS FACTOR 2,334
TOTAL ASSOCIATED COST AS BOTH 23,275

DIRECTLY ALIGNED SAFETY PROGRAMS 301
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .203, 225, 416,419

FIGURE B-44. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-TURBULENCE ASSOC. WITH CLOUDS/STORMS (82*L)



TOTAL ASSOCIATED FATALITIES. 165

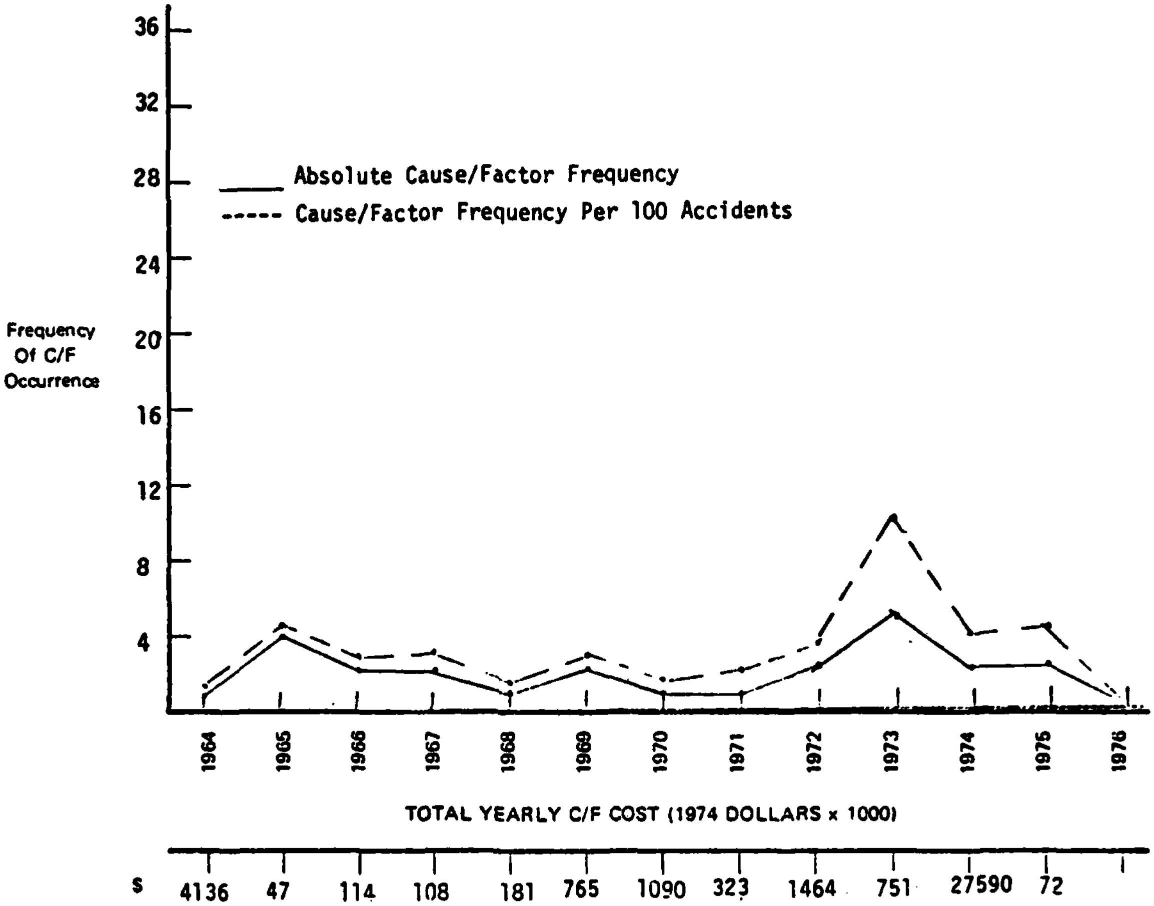
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . 12
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 27
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 39

TOTAL ASSOCIATED COST AS CAUSE 16,980
TOTAL ASSOCIATED COST AS FACTOR 1,821
TOTAL ASSOCIATED COST AS BOTH. 18,801

DIRECTLY ALIGNED SAFETY PROGRAMS . . .301
INDIRECTLY ALIGNED SAFETY PROGRAMS . . .416, 419

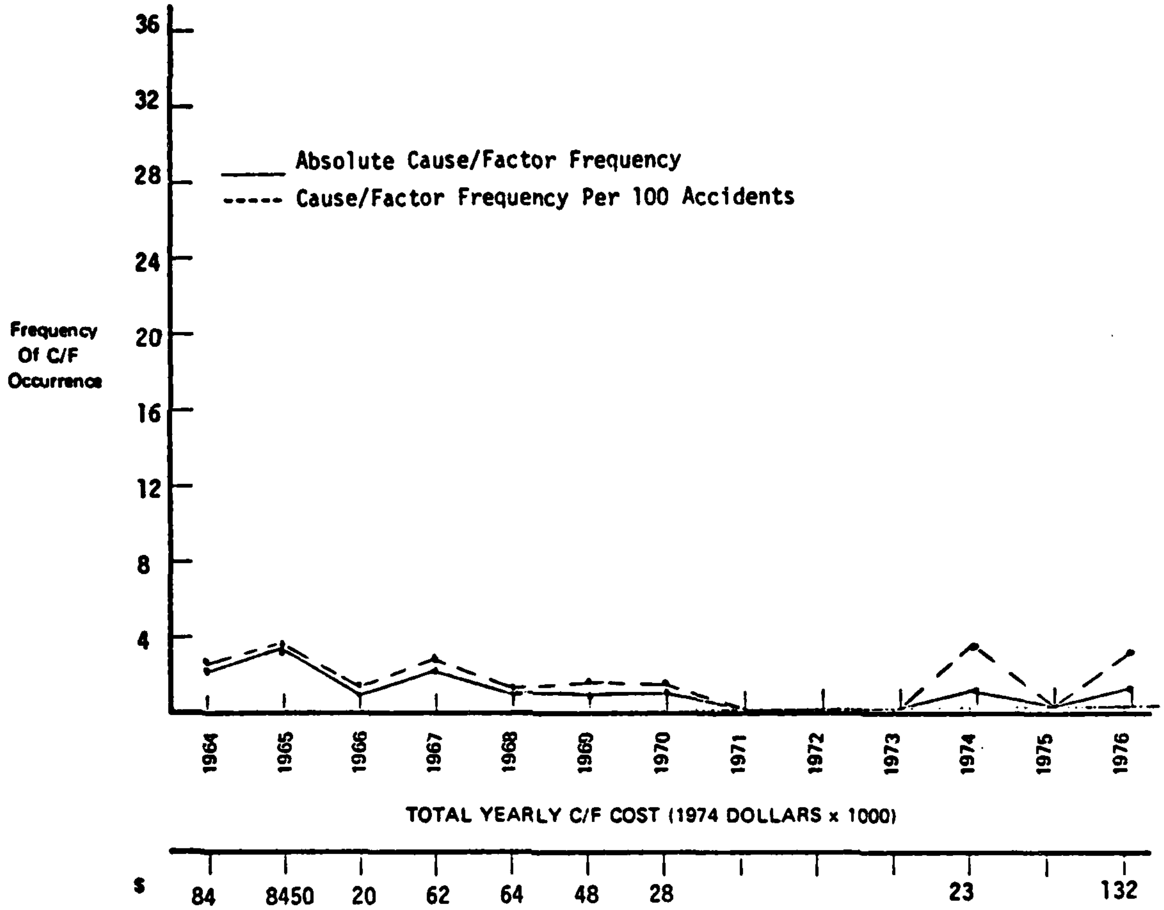
FIGURE B-45. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: WEATHER-THUNDERSTORMS (82*X)

84*00 includes G, O, 1, D, A, 2, 9, E



TOTAL ASSOCIATED FATALITIES	158
TOTAL ACCIDENTS ASSOCIATED AS CAUSE . .	20
TOTAL ACCIDENTS ASSOCIATED AS FACTOR :	5
TOTAL ACCIDENTS ASSOCIATED AS BOTH. . .	25
TOTAL ASSOCIATED COST AS CAUSE . . .	36,525
TOTAL ASSOCIATED COST AS FACTOR . . .	116
TOTAL ASSOCIATED COST AS BOTH	36,641
DIRECTLY ALIGNED SAFETY PROGRAMS . .	212, 303
INDIRECTLY ALIGNED SAFETY PROGRAMS .	216, 418, 422

FIGURE B-46. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: MISC.-MISC. (84*00)



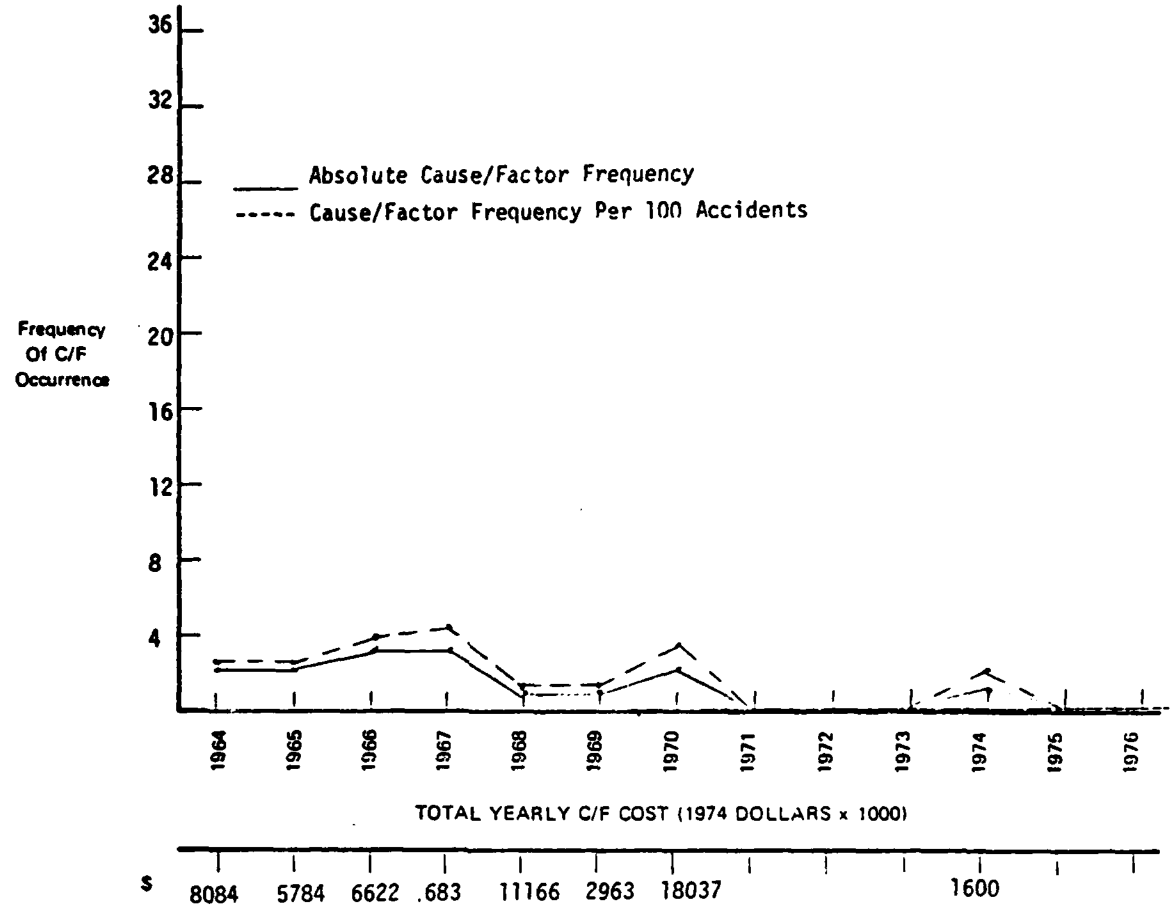
TOTAL ASSOCIATED FATALITIES 88

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 12
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . 1
TOTAL ACCIDENTS ASSOCIATED AS BOTH . . . 13

TOTAL ASSOCIATED COST AS CAUSE 8,561
TOTAL ASSOCIATED COST AS FACTOR 350
TOTAL ASSOCIATED COST AS BOTH 8,911

DIRECTLY ALIGNED SAFETY PROGRAMS 202, 206
INDIRECTLY ALIGNED SAFETY PROGRAMS . . . 201

FIGURE B-47. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: EVASIVE MANUVER TO AVOID COLLISION (84*7)



TOTAL ASSOCIATED FATALITIES. 248

TOTAL ACCIDENTS ASSOCIATED AS CAUSE . . . 15
TOTAL ACCIDENTS ASSOCIATED AS FACTOR . . . -
TOTAL ACCIDENTS ASSOCIATED AS BOTH 15

TOTAL ASSOCIATED COST AS CAUSE 54,939
TOTAL ASSOCIATED COST AS FACTOR . . . . -
TOTAL ASSOCIATED COST AS BOTH 54,939

DIRECTLY ALIGNED SAFETY PROGRAMS. . . . None
INDIRECTLY ALIGNED SAFETY PROGRAMS. . . None

FIGURE B-48. CAUSE/FACTOR FREQUENCY AND COST SUMMARY: UNDETERMINED (84*I)

APPENDIX C

ACCIDENT TYPE BY CAUSE/FACTOR

FREQUENCY OF ACCTYPE1 BY C/F

64*01

A	GROUND-WATER LOOP/SWERVE	15	B	DRAGGED WINGTIP,POD,FLOAT	1
C	WHEELS UP	4	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	4	F	GEAR RETRACTED	2
G	HARD LANDING	17	H	NOSE OVER/DOWN	2
I	ROLL OVER	--	J	OVERSHOOT	10
K	UNDERSHOOT	7	L0	COLLISION IN FLIGHT	5
L1	COLLISION ONE AIRBORNE	1	L2	COLLISION BOTH ON GROUND	2
M0	COLLISION WITH GRD/WATER CONTROLLED	14	M1	COLLISION WITH GRD/WATER UNCONTROLLED	10
N0	COLLIDED-WIRES/POLES	1	N1	COLLIDED -TREES	2
N2	COLLIDED-RESIDENCE	1	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	4	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	2
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	5
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	4	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	1	Q3	STALL -MUSH	3
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	3
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	20
V1	PROPELLER FAILURE	3	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	1
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	26	0	HAIL DAMAGE TO AIRCRAFT	2
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	4
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

64*02

A	GROUND-WATER LOOP/SWERVE	27	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	7	D	WHEELS-DOWN LADING WATER	2
E	GEAR COLLAPSED	2	F	GEAR RETRACTED	8
G	HARD LANDING	22	H	NOSE OVER/DOWN	3
I	ROLL OVER	--	J	OVERSHOOT	26
K	UNDERSHOOT	29	L0	COLLISION IN FLIGHT	3
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	4
M0	COLLISION WITH GRD/WATER CONTROLLED	13	M1	COLLISION WITH GRD/WATER UNCONTROLLED	6
N0	COLLIDED-WIRES/POLES	1	N1	COLLIDED -TREES	7
N2	COLLIDED-RESIDENCE	2	N3	COLLIDED -OTHER BUILDINGS	2
N4	COLLIDED-FENCE,FENCEPOSTS	1	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	1
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	7	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	4	ND	COLLIDED-PARKED AIRCRAFT	4
NE	COLLIDED - AUTOMOBILE	1	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	9	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	2	Q3	STALL -MUSH	6
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	15
V1	PROPELLER FAILURE	3	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	4	0	HAIL DAMAGE TO AIRCRAFT	1
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	1
3	UNCONTROLLED ALTITUDE DEVIATION	1	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	4
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

64*03

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	15
L1	COLLISION ONE AIRBORNE	1	L2	COLLISION BOTH ON GROUND	2
M0	COLLISION WITH GRD/WATER CONTROLLED	5	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	1	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	2
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	1
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	2	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

64*04

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	2	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	4
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	1
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	1
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

65*01

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	2
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	1
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	1	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

CAUSE FACTROS BY ACCIDENT TY

FREQUENCY OF ACCTYPE1 BY C/F

65*02

A	GROUND-WATER LOOP/SWERVE	8	B	DRAGGED WINGTIP,POD,FLOAT	2
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	1
G	HARD LANDING	15	H	NOSE OVER/DOWN	1
I	ROLL OVER	--	J	OVERSHOOT	6
K	UNDERSHOOT	3	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	1	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	1	N1	COLLIDED -TREES	1
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

65*03

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	1
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	1	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

66*02

A	GROUND-WATER LOOP/SWERVE	3	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	3	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	2
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AI-FRAME FAILURE IN FLIGHT	--	S1	AIRFFAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	4
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLEF/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

67*01

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	1
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

CAUSE FACTROS BY ACCIDENT TYP

FREQUENCY OF ACCTYPE1 BY C/F

68*00

A	GROUND-WATER LOOP/SWERVE	2	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	2	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	7	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	1
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	2
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	4
M0	COLLISION WITH GRD/WATER CONTROLLED	2	M1	COLLISION WITH GRD/WATER UNCONTROLLED	4
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	1
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	2	N7	COLLIDED-AIRPORT HAZARD	1
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	3	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	1	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	2	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	1
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	10
V1	PROPELLER FAILURE	2	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	3
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	9	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	2
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	10
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*D0

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	5	F	GEAR RETRACTED	2
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	4	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	2	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	5
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	1	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	3
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*D4

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	2	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	1
S0	AI-FRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	1	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	3
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*06

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	8	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	6	F	GEAR RETRACTED	1
G	HARD LANDING	1	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	3	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	1	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	2
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*G9

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	1	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	6
L1	COLLISION ONE AIRBORNE	2	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	2	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	1	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	1	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	3	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	1
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*K0

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	21
L1	COLLISION ONE AIRBORNE	1	L2	COLLISION BOTH ON GROUND	6
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHEXP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	P ELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PPOPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	6
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*K1

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	4
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	3
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*K3

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	2	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLEF/ROTOR ACCIDENT-PERSON	7
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	5
7	UNDETERMINED	--			

CAUSE FACTROS BY ACCIDENT T

FREQUENCY OF ACCTYPE1 BY C/F

68*K4

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	1
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	54	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	18
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*K9

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	2	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	3
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	1	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*J0

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	2	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	1	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PPOPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*R

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TPEES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	32	0	HAIL DAMAGE TO AIRCRAFT	1
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	8
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

68*R0

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHEFP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	6	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*00

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	2	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	4	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	1
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	1	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	7	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	3	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	1	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	2
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CA

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	14	F	GEAR RETRACTED	--
G	HARD LANDING	1	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

CAUSE FACTROS BY ACCIDENT TY

FREQUENCY OF ACCTYPE1 BY C/F

70*CB

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	8	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	6	F	GEAR RETRACTED	3
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	2	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CC

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	7	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	2	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CE

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	3	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	11	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	2
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CF

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	4	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	3
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	4
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CJ

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	1	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

70*CM

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	4	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCF	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILF	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

74*00

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	4	R1	FIRE ON GROUND	3
S0	AIRFRAME FAILURE IN FLIGHT	2	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	42
V1	PROPELLER FAILURE	7	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

74*AD

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	6
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

74*ME

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	2
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	6
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

75*00

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	6
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-ANIMALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	1
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	1	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	4	R1	FIRE ON GROUND	7
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	2
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	8
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

75*80

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	1
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	1
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	2	R1	FIRE ON GROUND	2
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

76*00

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	1
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N3	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	1	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	1
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	3
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

78*00

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	2	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

80*00

A	GROUND-WATER LOOP/SWERVE	11	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	1	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	5
K	UNDERSHOOT	7	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	1	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	1
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	1
NC	COLLIDED-SNOWBANK	4	ND	COLLIDED-PARKED AIRCRAFT	1
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	1	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

60*BA

A	GROUND-WATER LOOP/SWERVE	7	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	2	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	14
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*00

A	GROUND-WATER LOOP/SWERVE	4	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	3	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	6	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	13
K	UNDERSHOOT	15	L0	COLLISION IN FLIGHT	5
L1	COLLISION ONE AIRBORNE	4	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	28	M1	COLLISION WITH GRD/WATER UNCONTROLLED	17
N0	COLLIDED-WIRES/POLES	2	N1	COLLIDED -TREES	11
N2	COLLIDED-RESIDENCE	2	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	1
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	5	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	2	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	2	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	1	Q3	STALL -MUSH	1
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	3
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	4	0	HAIL DAMAGE TO AIRCRAFT	3
1	LIGHTING STRIKE	4	2	EVASIVE MANEUVER	1
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*B

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	3	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	7
K	UNDERSHOOT	4	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	6	M1	COLLISION WITH GRD/WATER UNCONTROLLED	2
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	1
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	1	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	4
V1	PROPELLER FAILURE	1	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*H

A	GROUND-WATER LOOP/SWERVE	10	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	3	H	NOSE OVER/DOWN	1
I	ROLL OVER	--	J	OVERSHOOT	2
K	UNDERSHOOT	4	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	1	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	1	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	1
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*K

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NF	COLLIDED - AUTOMOBILE	--	NE	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	66	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*L

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	2	M1	COLLISION WITH GRD/WATER UNCONTROLLED	1
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	2	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	110	0	HAIL DAMAGE TO AIRCRAFT	1
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	2
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

82*X

A	GROUND-WATER LOOP/SWERVE	1	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	2	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	4	M1	COLLISION WITH GRD/WATER UNCONTROLLED	1
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	1
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD. STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	25	0	HAIL DAMAGE TO AIRCRAFT	1
1	LIGHTING STRIKE	2	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

84*00

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	1	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	1	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	1
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPPOACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-ANIMALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	1
S0	AIRFRAME FAILURE IN FLIGHT	1	S1	AIRFRAME FAILURE ON GROUND	1
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	5
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	4	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	3
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

84*7

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	--
G	HARD LANDING	--	H	NOSE OVER/DOWN	--
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	--	L0	COLLISION IN FLIGHT	1
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	--	M1	COLLISION WITH GRD/WATER UNCONTROLLED	--
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	--
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	--	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	12
3	UNCONTROLLED ALTITUDE DEVIATION	--	4	DITCHING	--
5	MISSING AIRCRAFT	--	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	--			

FREQUENCY OF ACCTYPE1 BY C/F

84*I

A	GROUND-WATER LOOP/SWERVE	--	B	DRAGGED WINGTIP,POD,FLOAT	--
C	WHEELS UP	--	D	WHEELS-DOWN LADING WATER	--
E	GEAR COLLAPSED	--	F	GEAR RETRACTED	2
G	HARD LANDING	--	H	NOSE OVER/DOWN	1
I	ROLL OVER	--	J	OVERSHOOT	--
K	UNDERSHOOT	1	L0	COLLISION IN FLIGHT	--
L1	COLLISION ONE AIRBORNE	--	L2	COLLISION BOTH ON GROUND	--
M0	COLLISION WITH GRD/WATER CONTROLLED	2	M1	COLLISION WITH GRD/WATER UNCONTROLLED	2
N0	COLLIDED-WIRES/POLES	--	N1	COLLIDED -TREES	3
N2	COLLIDED-RESIDENCE	--	N3	COLLIDED -OTHER BUILDINGS	--
N4	COLLIDED-FENCE,FENCEPOSTS	--	N5	COLLIDED-ELECTRNIC TOWERS/WIRES	--
N6	COLLIDED-RUNWAY/APPROACH LIGHTS	--	N7	COLLIDED-AIRPORT HAZARD	--
N8	COLLIDED-AMINALS,LIVESTOCK	--	N9	COLLIDED-CROP	--
NA	COLLIDED-FLAGMAN,LOADER	--	NB	COLLIDED-DITCHES	--
NC	COLLIDED-SNOWBANK	--	ND	COLLIDED-PARKED AIRCRAFT	--
NE	COLLIDED - AUTOMOBILE	--	NF	COLLIDED -DIRT BANK	--
NY	COLLIDED-OTHERP BIRD STRIKE	--	Q1	STALL SPIN	--
Q2	STALL-SPIRAL	--	Q3	STALL -MUSH	--
R0	FIRE IN FLIGHT	1	R1	FIRE ON GROUND	--
S0	AIRFRAME FAILURE IN FLIGHT	--	S1	AIRFRAME FAILURE ON GROUND	--
T	ENGINE TEARAWAY	--	U	ENGINE FAILURE OR MALFUNCTION	--
V1	PROPELLER FAILURE	--	V2	TAIL ROTOR FAILURE	--
V3	MAIN ROTOR FAILURE	--	W	PROPELLER/ROTOR ACCIDENT-PERSON	--
X	JET INTAKE/EXHAUST ACCIDENT -PERSON	--	Y	PROPELLER/JET/ROTOR BLAST DAMAGE	--
Z	TURBULENCE	--	0	HAIL DAMAGE TO AIRCRAFT	--
1	LIGHTING STRIKE	--	2	EVASIVE MANEUVER	--
3	UNCONTROLLED ALTITUDE DEVIATION	1	4	DITCHING	--
5	MISSING AIRCRAFT	1	6	MISCELLANEOUS/OTHER	--
7	UNDETERMINED	1			

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